DOT/FAA/AM-98/23

Office of Aviation Medicine
Washington, D.C. 20591

Recovery of the FAA Air Traffic Control Specialist Workforce, 1981-1992

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August 1998

Final Report

This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

U.S. Department of Transportation

Federal Aviation Administration

NOTICE

Technical Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT/FAA/AM-98/23		

4. Title and Subtitle	5. Report Date
Recovery of the FAA Air Traffic Control Specialist Workforce, 1981–1992	August 1998
	6. Performing Organization Code
7. Author(s) Dana Broach, Editor	8. Performing Organization Report No.
9. Performing Organization Name and Address FAA Civil Aeromedical Institute P.O. Box 25082 Oklahoma City, OK 73125	10. Work Unit No. (TRAIS) 11. Contract or Grant No.
12. Sponsoring Agency Name and Address Office of Aviation Medicine Federal Aviation Administration 800 Independence Avenue, S. W. Washington, DC 20591	13. Type of Report and Period Covered

15. Supplementary Notes
This research was conducted under task AM-97-B-HRR-509

16. Abstract

The Federal Aviation Administration was confronted in 1981 with the challenge of rebuilding its core, technical, and highly-trained air traffic control specialist (ATCS) workforce following the PATCO strike. From late 1981 through mid-1992, the FAA rebuilt this critical workforce through a large-scale testing, screening and training program. By mid-1992, recovery of the controller workforce was complete, and it was no longer necessary for the FAA to conduct a large-scale hiring program. The six papers presented in this report represent the first major retrospective analysis of the complete data set describing the recovery of the FAA's en route and terminal ATCS workforce following the 1981 controller strike. The first paper describes the personnel processes, focusing on recruitment and hiring programs for the en route and terminal options. The second paper presents a detailed description of the aptitude test battery used to evaluate over 400,000 applicants between 1981 and 1992. The third paper offers a definitive statistical portrait of the FAA Academy Screening programs as predictors of field training outcomes. On-the-job training (OJT) programs in en route and terminal facilities are described in the fourth paper. These four papers, taken together, provide a definitive description of the processes used to recruit, test, screen, and train persons for the ATCS occupation between 1981 and 1992. The fifth paper draws on FAA organizational survey data to describe controller perceptions of the organizational climate in which the workforce recovery occurred. The sixth paper analyzes current controller workforce demographics and technological trends in air traffic control to identify potential areas of future research.

17. Key Words	18. Distribution Statement
Air Traffic Control Specialist (ATCS) Selection; Training; Personnel, FAA; Psychology; Organizational Climate; Demographics	Document is available to the public through the National Technical Information Service, Springfield, VA 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
UNCLASSIFIED	UNCLASSIFIED	62	

Form DOT F 1700.7 (8-72)

Reproduction of completed page authorized

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GLOSSARY OF ABBREVIATIONS AND STATISTICAL TERMS

ABSR	Abstract Reasoning Test
α	"Cronbach's alpha;" A measure of the internal consistency of a set of items. a ranges from 0 to 1, and indicates how much the items in a scale are measuring the same thing.
ANOVA	Analysis of variance
ARTCC	Air Route Traffic Control Center
ATA	Air Traffic Assistant
ATC	Air traffic control
ATCS	Air Traffic Control Specialist
β	"Beta weight," or standardized regression coefficient; used to weight each *X* predictor in a multiple regression equation
CAMI	Civil Aeromedical Institute, Oklahoma City, Oklahoma
CSC	Civil Service Commission
CST	Controller Skills Test
η^2	"Eta-squared;" A type of correlation coefficient that can be used to express a curvilinear relationship between 2 variables
F	Statistic computed in analyses of variance, used for testing the statistical significance of the amount of variance accounted for in one (or more) dependent variables by one (or more) independent variables
FAA	Federal Aviation Administration
FPL	Full performance level controller
FSS	Flight Service Station
GAO	General Accounting Office
M	Statistical symbol for the mean (or average)
MANOVA	Multiple analysis of variance
MCAT	Multiplex Controller Aptitude Test
N	Statistical symbol for number of persons in sample or analysis
NAS	National Airspace System
NTIS	National Technical Information Service, Springfield, VA
OAM	Office of Aviation Medicine
OJT	On-the-job training
OKT	Occupational Knowledge Test
OPM	U.S. Office of Personnel Management
p	"P-value." A statistical symbol indicating the probability of obtaining a result by chance alone 5 times or less in 100 ($p \leq .05$), 1 time or less in 100 ($p \leq .01$), or 1 time or less in 1000 ($p \leq .001$) independent samples
PATCO	Professional Air Traffic Controller Organization
R	Statistical symbol for the multiple correlation between a single criterion (Y) and multiple predictors (X_1, X_2, ... X_i). *R* may range between 0 and 1, with 1 indicating that Y is perfectly predicted by some weighted combination of Xs. In multiple regression analysis, the values on one or more predictors (X_1, X_2, ... X_i) are used to predict or estimate values on the criterion (Y). Each predictor is statistically weighted by the standardized regression coefficient (b) such that overall errors in the prediction of Y values are minimized. The degree of overall linear relationship between Y and the predictors X_1, X_2, ... X_i is indexed by the multiple correlation (*R*). An *R* of 1.0 indicates that Y is perfectly predicted from the combination of predictors, and an *R* of 0 indicates that Y cannot be predicted from any of the predictors.

GLOSSARY OF ABBREVIATIONS AND STATISTICAL TERMS

R^2	"R-squared;" Statistical symbol for the squared multiple correlation. R^2 estimates the proportion or amount of variability in criterion (Y) values or scores accounted for or explained by the optimally weighted combination of predictors.
RATING	Final civil service rating at hire, based on OPM test scores and veteran's preference points
SCREEN	Variable representing controller performance in the FAA Academy ATCS initial qualifications training program
SD	Statistical symbol for standard deviation
STATUS	Variable representing outcomes in controller on-the-job field training at the first assigned field air traffic control facility
TMC	Transmuted Composite score, a weighted sum of ABSR and MCAT scores on the OPM test battery
VFR	Visual Flight Rules
VRA	Veterans Readjustment Act
Z	Statistical symbol used to denote the magnitude of difference between two proportions in terms of the area under a normal curve. *Z* is a statistic used for testing if two proportions are truly different from each other, taking into account the base population on which the proportions are calculated. The likelihood of obtaining a *Z* (or any other statistic) by chance alone in 100 or 1000 analyses based on different samples is the significance (p) of the statistic. A $p \leq .05$, $\leq .01$, or $\leq .001$ indicates that less than 5 in 100, 1 in 100, or 1 in 1000 such analyses, respectively, would yield a statistic of that magnitude by chance alone.

INTRODUCTION

Dana Broach

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On August 3, 1981, the majority of the nation's air traffic controllers went on strike. On August 5, 1981, President Reagan summarily fired the controllers who had not returned to work. The controller strike left 4,669 operational controllers available in August 1981 to staff the nation's Air Route Control Centers, terminal radar approach control, and airport control towers (National Transportation Safety Board, 1981). The Federal Aviation Administration (FAA) confronted a challenge unique in the annals of American government: that of rebuilding a core, technical, highly trained workforce in an occupation directly responsible for the safety of millions of lives on a daily basis. From late calendar year 1981 to mid-year 1995, the FAA rebuilt this critical workforce through a large-scale testing, screening and training program.

The testing and screening programs operated from 1981 through March, 1992. Field training data collection ended in the summer of 1995. By then, the controller workforce was near its pre-strike level, with about 14,400 controllers working in the nation's en route centers, terminal radar facilities, and airport towers. Throughout this period, the Civil Aeromedical Institute conducted a longitudinal research program focused on the validation of the air traffic control specialist (ATCS) selection program.

The following papers represent the first major retrospective analysis of the complete data set describing the recovery of the FAA's en route and terminal ATCS workforce following the 1981 controller strike.

In the first paper, Jay Aul describes the personnel processes supporting the recovery of the controller workforce, focusing on recruitment and hiring programs for the center and terminal options.

Second, a detailed description of the numbers of persons tested and the instrument used to test for aptitude are presented by Dana Broach. The second paper also evaluates the validity of the test battery as a predictor of performance at the FAA Academy and in the field.

The third paper, by Pam Della Rocco, offers a definitive statistical portrait of the 1981 to 1992 FAA Academy screening programs for the en route and terminal options. Della Rocco also evaluates the validity of the FAA Academy screening programs as predictors of field training outcomes.

Fourth, the on-the-job training (OJT) program in en route and terminal field facilities through June, 1995, is described by Carol Manning. These papers, taken together, provide a definitive description of the processes used to test, screen, and train persons for the ATCS occupation between 1981 and 1992.

The fifth paper, by Richard Thompson, chronicles air traffic controller perceptions of organizational climate in which this recovery occurred, drawing on FAA survey data and documented organizational initiatives.

Finally, the demographics of the current ATCS workforce, projections about future trends and possible requirements, and potential areas of research in relation to both demographic and technological trends, are described by David Schroeder, Dana Broach, and Bill Farmer.

CHAPTER 1:

EMPLOYING AIR TRAFFIC CONTROLLERS, 1981–1992

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The civil service procedures and processes used to recruit and select air traffic control specialists (ATCS) following the 1981 controller strike are described. Recruitment approaches and strategies, basic occupational qualifications requirements for applicants applying under competitive rules, and additional selection criteria such as an interview, medical examination, and security and suitability investigation are presented. Different noncompetitive employment processes, such as cooperative education, are briefly surveyed, concluding with current trends in controller selection.

On August 3, 1981, 10,438 members of the Professional Air Traffic Control Organization (PATCO) staged a job action, or strike, against the Federal government. On August 5, 1981, President Reagan summarily fired the controllers who had not returned to work. The PATCO strike left 4,669 operational controllers available in August 1981 to staff the nation's airport control towers, terminal radar approach control facilities, and Air Route Traffic Control Centers (National Transportation Safety Board, 1981). The Federal Aviation Administration (FAA) needed to rebuild as quickly and prudently as possible after the loss of more than half of its controller workforce. As the FAA's air traffic controllers, more properly called air traffic control specialists (ATCSs), are civil servants, the employment process was governed by United States federal civil service laws and regulations. The regulatory agency overseeing these laws and regulations was the U.S. Office of Personnel Management (OPM). The rules and regulations resulted in well-defined and rather strict employment procedures to ensure that there was open and fair competition for controller positions in the FAA. The purpose of this paper is to provide an overview of the employment procedures used by the FAA to recruit and select ATCSs during the recovery from the 1981 strike.

Recruitment

The process logically began with finding and attracting controller candidates. Under civil service rules, job openings must be advertised in a way that ensures open competition. The government calls these advertisements "vacancy announcements." In concrete form, they are printed documents that contain certain detailed information, disclaimers, and statements. The announcements must also be distributed to organizations, such as state employment services. Advertising was not only a legal requirement, it was a practical necessity during the recovery period. The traditional sources of candidates were former military controllers (Collins, Manning, & Taylor, 1984), and people who knew about the job from some kind of personal contact. That contact often turned out to be relatives or neighbors who were air traffic controllers. Those sources were insufficient to rebuild the work force after the 1981 strike. To hire enough people, it was necessary for the FAA to recruit from the general population. Advertising also had to overcome the perception that the strike circumstances did not make the job the of an ATCS sound appealing. The FAA and controller jobs received much negative publicity in the years following the strike. Moreover, the FAA was competing for a scarce resource consisting of people under age 31 who could score high on the civil service examination for air traffic control positions. The military and private sectors also valued and tried to attract bright young people.

The first post strike vacancy announcements were little different from those issued by other government agencies. They were several pages printed in black ink on white paper, and the only graphic was the agency logo. There was an attempt shortly after the strike to create a more attractive, exciting announcement. That turned out to be a picture of an airliner taking off, with a banner above it saying something like, "Control the Skies." Unfortunately, the picture was

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printed with red ink. With the smoke or dust trailing the aircraft, it looked to some people as if the airliner was in trouble. That particular format for the announcement was dropped. At the same time, for budget reasons, there were government-wide restrictions on printing in multiple colors. Eventually, however, the FAA received permission to print its announcement as a four-color glossy brochure. The brochure was quite different from the standard government vacancy announcement. In addition to the required information, it contained a brief story outlining how controllers handle a single airline flight. There were sample items from the civil service examination for air traffic controllers and color pictures of controllers at work in various settings. The FAA built a staff of full time recruiters who sought out sources of applicants. The FAA learned to use other recruitment methods during this period as well. FAA field personnel offices frequently used newspaper advertisements to recruit. Magazine, television, and radio advertisements were also used in some markets (Schultz & Marshall-Mies, 1988).

Selection

Competitive processes

Basic qualifications and pre-hire testing. One reason that extensive recruitment was necessary was that potential controllers had to meet a number of qualifications requirements. First, they had to be United States citizens. Second, in most cases, they could be no younger than 18 years of age. They could not have reached their 31st birthday prior to initial appointment into the terminal or en route options. To qualify for consideration at the entry level civil service grade 5 ("GS-5"), an applicant needed some combination of undergraduate or graduate level education, progressively responsible work experience, and/or specialized aviation experience. Candidates were also required to take (and pass) the OPM civil service examination for air traffic control specialists. This written test was designed to identify people with the aptitude to be air traffic controllers (Broach, this volume). Under Title 5 of the U.S. Code of Federal Regulations, all such civil service entrance examinations must be scored on a scale of 100. The bottom point is not designated in the regulations. The passing score for a civil service test must be set at 70. To avoid adverse impact against minority groups and women, OPM required that the score of 70 on this test be calibrated to the 50th percentile of the population applying for these jobs at the GS-5 grade level.

However, most recruitment was for grade 7 ("GS-7"), which was the more common entry grade for the controller occupation. The qualifying score on the written ATCS aptitude test for the GS-7 grade level was 75.1 for applicants without prior specialized experience or education. To qualify for GS-7 with a score of 70, an individual had to have additional experience or education. Typically, this was certain kinds of aviation experience, one year of graduate school, or superior grades in college. Federal law also required that extra points be given to certain military veterans. The matter of who received these extra points is too complex to fully explain here. For simplicity, it can be explained as including veterans of the U.S. military, who served in declared wars, or in military actions for which campaign badges or expeditionary medals were awarded. Normally, five extra points were added onto the examination score for veteran's meeting these criteria. If the veteran had a military service-related disability, he or she received ten extra points, instead of five. Veterans also had priority in hiring over non-veterans. For example, a candidate with veteran's preference had priority in hiring over a candidate with the same score, but without the veteran's preference.

Interview, medical, and security criteria. Candidates were also interviewed. The interview had several purposes. One key purpose was to provide information to the candidates about the ATCS occupation. Most candidates did not have a clear understanding of the work of air traffic controllers. It was important to explain the concept of rotating shift work, because many did not understand it. It was also a chance for the interviewer to evaluate the candidate for such factors as ability to speak clearly and to speak in English. Interviewers were asked to make a hiring recommendation for each candidate, although the interview was rarely used to screen out candidates.

Candidates who progressed through these hurdles then had to meet the medical requirements for these positions. The medical standard for entry into these positions was (and is) quite strict. It included vision and hearing standards, as well as a form of mental health screen. Personality assessment has been used formally by the FAA in conjunction with the ATCS programs since 1965 (Convey, 1984). From the outset, the 38-item

subset from the two 187-item parallel forms of the Sixteen Personality Factor Questionnaire (16PF; Cattell, Eber, & Tatsuoka, 1970) was intended to operate as an indicator of emotional instability. Candidates flagged by the 38-item scale were referred for psychiatric and psychological evaluation.

Finally, the candidates had to pass a background investigation. This investigation was used for two purposes. One was to determine if the person would receive a security clearance. The other was to determine the person's general suitability for federal employment. Individuals who had been found guilty of crimes, who had been discharged from the military under less than honorable conditions, who had been fired with cause from previous employers, or who had been convicted of any alcohol or drug-related offense had great difficulty being cleared under this process. The FAA also looked with caution on people who had repeated minor violations, such as multiple speeding tickets.

Large numbers of people were processed under these procedures. At peak, nearly 50,000 people were tested in a year. During the first years after the strike, the FAA's personnel offices were required to recruit and hire specific numbers of people for each new class date at the FAA Academy. These numbers were set ambitiously high; initially, therefore, a few people with test scores as low as 70 were sent to the FAA Academy. Over time, the FAA was able to recruit and hire people with increasingly higher test scores. During the late 1980s until 1992, the minimum hiring scores varied from about 85 to about 95.

Post-hire screening. Once someone met the basic eligibility criteria, passed the OPM test, was medically cleared, passed a background investigation, and was interviewed, the person was usually hired. However, the selection process did not stop there. Selectees reported to the FAA Academy screening program in Oklahoma City, Oklahoma (Della Rocco, this volume). The individuals were officially appointed into the civil service at the FAA Academy, becoming paid employees of the FAA. They spent the first several weeks of their employment in the FAA Academy screening program. The FAA Academy program was considered to be initial training, but was conducted with an emphasis on screening out those unlikely to be successful in further FAA controller training (Boone, 1984). The last version of the screening program was approximately nine weeks long. Those who failed the FAA Academy program usually had their employment terminated. The pass rate varied, but was about 60 percent for most of the period it operated. On average, about 30 percent failed outright, and another 10 percent withdrew from the program. This meant that nine weeks after starting with the FAA, approximately 40 percent of the new hires might no longer be employed with the agency.

Re-engineering the selection process. The process described up to this point was quite lengthy. In 1988, it was estimated to take on average 18 months to hire an entry level controller to send to the FAA Academy. In particular, it might take several months to obtain a background check on someone or to medically clear someone who required a special review of his or her medical situation. As a result, in the late 1980s the FAA embarked on what today would be called a "reengineering project." It successfully reengineered the hiring process for entry level controllers and effectively reduced the time to hire from 18 months to about six weeks. This was, however, late in the post-strike recovery period and many people still experienced delays due to existing backlogs of work. There was another complicating factor in the hiring process. A number of companies discovered a market for teaching people to take the OPM test. These companies aggressively marketed their services and, as a result, may have brought many more applicants to the FAA. Unfortunately, we also know that the more times a person takes the test, the lower the relationship between test score and success in the FAA Academy screening program (Broach, Young, & Farmer, 1994; Collins, Nye, and Manning, 1990). From evidence like this, we concluded that the test was subject to practice effects. The graduates of these training programs may have had inflated scores on the test, and this could have contributed to some increases that were seen in the failure rates at the FAA Academy in the late 1980s.

Noncompetitive processes

So far, only the conventional, competitive hiring process has been described. Other legitimate, but less well- known processes were also used. One such method was cooperative education. The FAA formally recruited students at colleges in certain majors, such as aviation, mathematics, geography, and engineering. As employees in the FAA's cooperative education program, the students alternated periods of training to be controllers at the FAA with periods of study in college. College graduates who met all the requirements described previously, and completed the cooperative education training program, could be assigned to positions as entry

level controllers. They then attended the FAA Academy screening program. In addition, the FAA moved people internally from other occupations into controller jobs. Programs were established that allowed lower-graded employees to take the OPM written ATCS aptitude test battery, and bid for entry-level positions in air traffic control. Thus, for example, a secretary or clerical worker could compete for an entry level training position as a controller. The people hired under this program usually started as controllers below the normal GS-7 entry grade. They received additional training before they reached GS-7. The minimum passing scores on the OPM test still applied to them, and they were required to meet the same medical and background investigation requirements as other applicants. Of course, they also had to pass the FAA Academy screening program upon reaching the GS-7 grade.

Other alternative hiring methods centered around former military controllers. The FAA hired many former military controllers through the basic civil service hiring process, described at length in the first part of this paper. It was also not uncommon for the FAA to hire military controllers through alternative hiring procedures. For example, Congress established special, expedited hiring mechanisms for Vietnam-era veterans, and for people who had recently left military service. The FAA still required the test, medical, and background investigations when using this approach, but it was, nevertheless, somewhat easier to hire people by this method. Not uncommonly, former military controllers might be hired at one step above the normal entry grade, based on their military controller experience. These individuals could bypass the FAA Academy screening program and go directly into training at an FAA air traffic control facility. In 1988, the military services reduced the size of their forces. The FAA took advantage of the opportunity to hire military controllers (Manning & Aul, 1992). This program was conducted under very different procedures as authorized by OPM. The controllers were hired at the GS-9 grade, one grade above the normal entry grade. Above the GS-7 grade, the OPM test was optional. In this case, the agency chose not to use it. Instead, subject matter experts (personnel experts and controllers) rated the candidates' experience, education, and training. This was a daunting task, as there were over 1,400 eligible applicants. A standard rating guide, containing six factors, was used. All selectees had to meet the medical requirements and be cleared through a background investigation. In addition, FAA air traffic control staff contacted the selectees' former military facilities to verify their work experience and obtain references or recommendations. About 600 military controllers were hired in this way. They were placed directly into facility training, bypassing the FAA Academy screening program (Manning & Aul).

Current Trends in Controller Selection

On February 21, 1992, the FAA closed the process of hiring from the general population. No new applications to take the OPM test were processed, except for certain veterans who had a statutory right to take the examination. On August 12, 1993, President Clinton again permitted the former controllers who had left the agency in 1981 to be considered for employment with the FAA. The FAA accepted applications from the former controllers from September 1, 1993 through October 15, 1993. Over 5,000 applications were received in that short period. From 1992 until now, it has not been necessary to hire significant numbers of people. Between 1992 and 1997, the FAA hired approximately 100 controllers per year. This has been due to stable workforce with very low attrition and retirement rates (General Accounting Office, 1997), use of contractors to operate less busy non-radar towers, and a slower than anticipated growth in aviation in the early part of the decade.

However, the FAA may increase its hiring in the near future but under very different conditions. The reason for the hiring is primarily that attrition is anticipated to increase in the next five years, as the post-strike generation of controllers ages. The FAA is now starting to hire, to ensure that replacement staff are trained and ready when needed. The FAA estimates that about 500 new controllers per year will be needed over the next several years. The General Accounting Office (GAO) has recently produced slightly lower estimates (GAO, 1997); but both organizations point to the need for future hiring (Schroeder, Broach, & Farmer, this volume). Approximately 50 cooperative education students also began work study programs with the agency in 1997. These individuals will come to a different FAA. In April of 1996, the FAA was legally exempted from most of the civil service laws. The agency now has the authority to develop new and innovative personnel systems and, for many months, has been incorporating new procedures based on studies of the best practices in other organizations. Based on those best practices and lessons learned in the recovery of the controller workforce between 1981 and 1992, the FAA is developing and implementing innovative processes to select and train the next generation of air traffic controllers.

CHAPTER 2:
AIR TRAFFIC CONTROL SPECIALIST APTITUDE TESTING, 1981-1992

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Between 1981 and 1992, entry into the demanding air traffic control specialist (ATCS) occupation in the Federal Aviation Administration (FAA) was determined by applicant performance on a written aptitude test battery. That ATCS aptitude test battery was administered over 400,000 times between 1981 and 1992. The reliability, validity, and technical fairness of the test battery are evaluated in this paper. Available data indicated that the tests comprising the battery had acceptable reliability. A composite score on the test battery predicted performance in initial ATCS qualification training at the FAA Academy, but did not predict outcomes in field training. Evidence for differential prediction of FAA Academy outcomes on the basis of race and gender was found in the technical fairness analyses. However, the validity evidence supported using the battery as a mass testing tool by the FAA in rebuilding the controller workforce.

The Air Traffic Control Specialist (ATCS) occupation is the single largest (about 17,000) and most publicly visible occupational group in the Federal Aviation Administration (FAA). Air traffic controllers are at the heart of a web of radars, computers, and communication facilities that comprise an increasingly complex and busy air transportation system. Appropriate selection of personnel into these critical positions is an important human factors problem. From 1981 through 1992, the FAA used noncompensatory, multiple hurdles to select people into the ATCS occupation. The first hurdle was a written aptitude test battery administered by the U.S. Office of Personnel Management (OPM; Aul, 1991, this volume). Between 1981 and 1992, the test was administered over 400,000 times. Only 25,277 applicants were selected on the basis of their test scores to attend the FAA Academy initial controller training program, the second major hurdle in the FAA's selection process. The purpose of this paper is to describe the test battery and evaluate its psychometric characteristics.

Description of the ATCS Written Test Battery

The aptitude test battery used from 1981 to 1992 was developed in response to the inadequacies of a more traditional civil service battery that was in use from 1964 to 1981. The effectiveness of the 1964 civil service battery was questioned as early as 1970, in the final report of the Air Traffic Controller Career Committee (Corson, Berhard, Catterson, Fleming, Lewis, Mitchell, & Ruttenberg, 1970). A review of controller training in the mid-1970s concluded that improved selection methods could have substantial monetary implications for the agency (Henry, Ramrass, Orlansky, Rowan, String, & Reichenbach, 1975). A subsequent technical study of controller selection tests found that the 1964 test battery was, at best, marginal in predicting the job performance of controllers (Milne & Colmen, 1977). Cooperative research by scientists from the FAA Office of Aviation Medicine (Dailey & Pickrel, 1984a, b), Civil Aeromedical Institute (CAMI; Collins, Boone, & VanDeventer, 1984), and OPM (Rock, Dailey, Ozur, Boone, & Pickrel, 1982) resulted in the development, validation, and implementation of a new written ATCS aptitude test battery in 1981 following the strike by members of the Professional Air Traffic Controller Organization (PATCO).

Three tests comprised the new 1981 test battery: the Multiplex Controller Aptitude Test (MCAT), the Abstract Reasoning Test (ABSR), and the Occupational Knowledge Test (OKT). The MCAT was a timed, paper-and-pencil test simulating activities required for control of air traffic. Aircraft locations and direction of flight were indicated with graphic symbols on a simplified, simulated radar display (Figure 2–1); an accompanying table provided relevant

information required to answer the item, including aircraft altitudes, speeds, and planned routes of flight. MCAT test items required examinees to identify situations resulting in conflicts between aircraft, to solve time, speed, and distance problems, and to interpret the tabular and graphical information. The ABSR was a 50-item civil service examination (OPM-157). To solve an item, examinees determined what relationships existed within sets of symbols or letters. The examinee then identified the next symbol or letter in the progression or the element missing from the set. A sample ABSR item is presented in Figure2-2. The OKT was an 80-item job knowledge test that contained items related to seven knowledge domains generally relevant to aviation, and specifically relevant to air traffic control phraseology and procedures. The OKT was developed as an alternative to self-reports of aviation and air traffic control experience. The OKT was found to be more predictive of performance in ATCS training than self-reports (Dailey & Pickrel, 1984b; Lewis, 1978).

The scoring of the MCAT, ABSR, and OKT is presented in Table 2-1. The sum of the weighted MCAT raw score and the ABSR score was then transformed into a linear composite ranging from 19.5 to 100. This "Transmuted Composite" (TMC) score was used to determine employment eligibility. For applicants without specialized prior experience, education, or superior academic achievement, a minimum TMC of 75.1 was required to qualify at the entry level GS-7 grade (Aul, 1991, this volume). If an applicant achieved the minimum TMC, extra points were awarded on the basis of scores on the OKT, as noted in Table 2-1. The final civil service rating (RATING) was the sum of TMC, extra points on the basis of OKT scores, and any adjudicated veteran's preference points. Ranking, referral, and selection were based on an applicant's final RATING. In general, only those competitive applicants with a RATING of at least 90 were selected by the FAA for employment as controllers. The distributions of applicant and selectee RATING scores are presented in Figure 2-3, based on over 200,000 applicant records archived at CAMI for research purposes.

Psychometric Characteristics

Reliability

Reliability in testing refers to the degree to which scores on a test are free from errors of measurement (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1985). Test-retest reliability is an estimate of the degree to which a person will obtain approximately the same score when re-tested after some time interval. The test-retest correlation for the MCAT was estimated at .60 in a sample of 617 newly-hired controllers (Rock, Dailey, Ozur, Boone, & Pickrel, 1981, p. 59). Parallel form reliability estimates the degree to which an applicant will obtain approximately the same score on a different version of the same test. The parallel form reliability, as computed on the same sample, ranged from .42 to .89 for various combinations of items (Rock et al., p. 103). Internal consistency estimates the degree to which the items in a test are homogenous (Ghiselli, Campbell, & Zedeck, 1981). Lilienthal and Pettyjohn (1981) examined internal consistency and item difficulties for ten versions of the MCAT. Cronbach's alpha for the ten versions ranged from .63 to .93; the alphas for 7 of the 10 versions were greater than .80. The available data suggest that the MCAT had acceptable reliability but was vulnerable to practice effects. In contrast, no item analyses, parallel form, test-retest, or internal consistency estimates of the ABSR (OPM-157) test have been reported by the FAA. Therefore, no conclusion can be drawn about the measurement properties of the ABSR. Published data are available for the OKT. Parallel form reliability for the OKT ranged from .88 to .91 (Rock et al., p. 65, 70). The internal consistency estimate of reliability (Kuder-Richardson Formula 20 (KR-20); Kuder & Richardson, 1937) for a 100-item version of the OKT was .95 (Rock et al., p. 51). Lilienthal and Pettyjohn reported Cronbach alphas for ten versions of the OKT ranging from .85 to .94 on a sample of about 2,000 FAA Academy air traffic control students. However, test-retest estimates of reliability have not been published. The available data suggest that the OKT had acceptable reliability.

Validity

Validity generally refers to the appropriateness, meaningfulness, and usefulness of specific inferences made on the basis of test scores (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education, 1985). Validity in the specific context of employee selection, as discussed in the federal *Uniform Guidelines on Employee Selection Procedures*

(Equal Employment Opportunity Commission, 1978), refers to the degree to which test scores used for making employment decisions are predictive or correlated with important and/or critical work outcomes, elements, or behaviors. The ATCS aptitude test battery has been validated against two classes of work outcomes in previous studies: (a) performance in the FAA Academy initial training programs (SCREEN; Della Rocco, this volume); and (b) outcomes of on-the-job field training (OJT) at the first assigned field facility (STATUS; Manning, this volume).

As the final civil service RATING was the basis of operational personnel selection decisions, this retrospective analysis examined the validity of the final RATING as a predictor of these two criteria for the 15,876 controllers who survived the FAA Academy and were placed into field training between 1981 and 1992. The field training STATUS criterion was coded as follows: 1 = *Reached Full Performance Level*; 2 = *Still in Training (Developmental)*; 3 = *Switched facilities*; 4 = *Switched options*; and 5 = *Failed.* As recommended by Manning, persons who had attrited for reasons other than performance were excluded from the validity analysis. Because the samples had been truncated by selection first, on RATING, and second, by selection on FAA Academy score (SCREEN), corrections for restriction in range were made as shown in Table 2-2, using the formulae presented by Ghiselli, Zedeck, and Campbell (1984). Correlations between civil service RATING and FAA Academy SCREEN scores were corrected for direct restriction in range due to explicit selection on RATING. The corrections were based on the population standard deviations presented in the Tables 2-3 through 2-6. Correlations between FAA Academy (SCREEN) and field training outcomes (STATUS) were corrected for direct restriction in range due to explicit selection on the FAA Academy score. Finally, correlations between civil service RATING and field training outcomes were corrected for incidental restriction in range due to selection of the samples on FAA Academy SCREEN scores. The uncorrected, zero-order correlations are presented in the lower left corner of each correlation matrix and the corrected correlations in the upper right corner. The corrected correlation matrices for each sample were submitted to regression analysis to estimate the validity of RATING as a predictor of FAA Academy SCREEN and field training STATUS.

In view of the iterations of the FAA Academy initial training programs, described by Della Rocco, and differences in field training as described by Manning, the sample was divided into four groups: (a) 1982-85 FAA Academy Terminal program graduates assigned to training in the terminal option (Table 2-3); (b) 1982-85 FAA Academy En route program graduates assigned to field training in the en route option (Table 2-4); (c) 1986-92 FAA Academy Non-radar Screen assigned to field training in the terminal option (Table 2-5); and (d) 1986-92 FAA Academy Non-radar Screen graduates assigned to field training in the en route option (Table 2-6).

On one hand, this retrospective analysis found that the final civil service RATING had acceptable validity as a predictor of performance in initial training at the FAA Academy for all four groups. The uncorrected correlations between RATING and SCREEN were statistically significant and ranged from .178 to .222 across the four groups. The corrected correlations between civil service RATING and FAA Academy SCREEN ranged from .458 to .502. On the other hand, regression analyses of the corrected correlation matrices found that RATING was a relatively poor predictor of field training STATUS in three of the four FAA Academy and field training variations (Table 2-7). The standardized regression weight (β) for RATING was not statistically significant for graduates of 1982-85 Terminal Screen program assigned to field training in the terminal option (β = -.025, *ns*) or for 1986-92 Non-radar Screen program graduates assigned to either terminal (β = -.041, *ns*) or en route (β = -.010, *ns*) field training. However, RATING did enter into the regression equation predicting STATUS in en route field training, with a standardized regression weight of -.107 ($p \leq .001$), for graduates of the 1982-85 En Route Screen program, as shown in Table 2-7.

Fairness

The FAA, in its 1993 Diversity Plan, made a commitment to attract, retain, develop, and manage a diverse work force that visibly reflected the American population at large by the year 2000. Achieving this goal will require substantial changes in the demographic profile of the ATCS occupation. Air traffic control is a career field in which female and minority workers have been historically under-represented relative to the American population at large. The techni-

cal fairness of the written ATCS aptitude test battery was recently examined in a series of papers as the first step toward assessing to what degree, if any, the battery may have served as an "engine of exclusion" (Seymour, 1988) of women and minorities from the ATCS occupation (Young, Broach, & Farmer, 1996; Broach, Farmer, & Young, 1997). Technical fairness refers to the regression model of test bias for which there is a reasonable professional consensus, as embodied in the 1985 *Standards for Educational and Psychological Testing* (American Educational Research Association, American Psychological Association, & National Council on Measurement in Education), rather than a socially constructed standard regarding test use (Sackett & Wilk, 1994; Gottfredson, 1994). Technical fairness in the regression model, and under the *Uniform Guidelines on Employee Selection Procedures* (Equal Employment Opportunity Commission, 1978), encompasses two issues. First, the effect on protected groups arising from use of a particular cut score on the predictor must be evaluated. A selection rate for any protected group that is less than four-fifths (4/5 or 80%) of that of the majority group will "... generally be regarded by the Federal enforcement agencies as evidence of adverse impact" (29 CFR 1607.4.D). Second, where the use of a selection procedure results in adverse impact, the *Uniform Guidelines on Employee Selection Procedures* require that the test user evaluate the degree to which differential predictions of future job performance are made from selection test scores by subgroup (29 CFR 1607.14.B.(8).(b)).

Gender

Previous research on written ATCS selection tests suggested that mean score differences by gender were insignificant (Rock, Dailey, Ozur, Boone, & Pickrel, 1984a, pp. 476) and that, overall, "the evidence for adverse impact against women based, on this sample, was marginal, at best" (Rock, Dailey, Ozur, Boone, & Pickrel, 1984b, pp. 507). This conclusion was based on results of a 1984 study in which 57% of men (n = 3,835) passed the written test, compared to 45% of women (n = 1,473). The adverse impact ratio in this case was 0.78, rather than the 0.80 required under the "four-fifths rule of thumb." Young, Broach and Farmer (1996) analyzed archival records for 170,578 applicants. Based on test scores, OPM determined the eligibility of applicants for employment by the FAA. OPM codes indicating that an applicant had either failed the test ('IA') or scored too low for consideration ('IS') were categorized as test failures. All other ineligibility codes were categorized as "other ineligible," and excluded from the analysis. OPM codes indicating eligibility were categorized as "eligible" for employment. The adverse impact analysis compared the proportion of women considered eligible with that of men. The analysis is presented in Table 2-8. A significantly lower percentage of women (42.0%) than men (58.1%) were coded by OPM as eligible for employment as controllers, based on test scores (Z = -3.58, $p \leq .001$). The ratio of female to male selection rates was .72. Using the 4/5ths rule of thumb of the *Uniform Guidelines on Employee Selection Procedures*, it appeared that the use of scores on the written ATCS aptitude test battery to determine eligibility for employment in the ATCS occupation between 1981 and 1992 resulted in statistically significant adverse impact on female applicants.

Given the finding that there appeared to be adverse impact against women, the *Uniform Guidelines on Employee Selection Procedures* (29 CFR 1607.14.B.(8).(b)) and *Standards for Educational and Psychological Testing* (Standard 1.20, p. 17) next required an investigation of the relationship between test scores and job performance for evidence of differential prediction by subgroup. The classical, regression-based model of test bias was used as the analytic framework by Young, Broach, and Farmer to evaluate the degree to which the written ATCS test battery differentially predicted performance in initial ATCS qualification training at the FAA Academy. After correcting correlations between test score, FAA Academy composite score, and gender for explicit and implicit restrictions in range due to prior selection of the sample on aptitude test score, the null hypothesis of a common regression line for the genders was rejected, suggesting the presence of some degree of test bias. Statistically significant differences by gender in regression slopes and intercepts were found in the step-down regression analysis, indicating the need for separate regression equations for men and women. The regression line for men slightly over-predicted the performance of women in the FAA Academy, as shown in Figure 2-4. The practical consequence of the apparent differential prediction was that women effectively needed a higher test score than men to have an equal likelihood of passing the initial qualification training at the FAA Academy.

Race

A formal adverse impact analysis on the basis of race was not technically feasible, as racial identifiers were not collected for ATCS job candidates. However, previous research (Rock, Dailey, Ozur, Boone, & Pickrel, 1984) found that the OPM test battery had adverse impact against African-Americans and Hispanics. In view of the previous research, Broach, Farmer, and Young (1997) investigated the relationship between test scores and performance in the FAA Academy for evidence of differential prediction on the basis of race. The classical, regression-based model of test bias was again used as the analytic framework to evaluate the degree to which the written ATCS test battery differentially predicted performance in initial ATCS qualification training at the FAA Academy for African-American and white controllers. After correcting correlations between test score, FAA Academy composite score, and race for explicit and implicit restrictions in range, the null hypothesis of a common regression line for African-American and white controllers was rejected, suggesting the presence of some degree of test bias. Statistically significant differences by race in regression slopes and intercepts were found in the step-down regression analysis, indicating the need for separate regression equations for African-American and white controllers. The regression line for whites over-predicted the performance of African-Americans in the FAA Academy. The practical consequence of the apparent differential prediction was that African-American controllers effectively needed a higher test score than white controllers to have an equal likelihood of passing the initial qualification training at the FAA Academy, as shown in Figure 2-5.

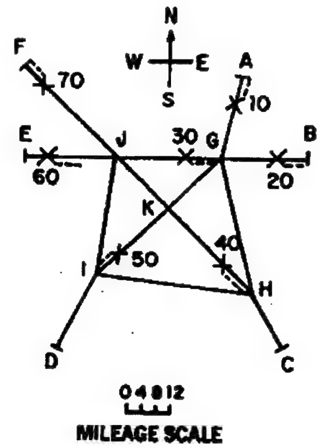
Discussion

The written ATCS aptitude test battery in use from 1981 through 1992 was developed to enable the agency to make reasonable predictions, for large numbers of applicants, about their future job performance as the basis for initial selection into a safety-related occupation. From a practical perspective, the primary function of the written ATCS test battery was to winnow a huge pool of applicants down to a smaller, manageable number suitable for further intensive, expensive evaluation. On one hand, the written ATCS aptitude test battery, as used from 1981 to 1992, achieved that organizational goal. The tests comprising the battery produced reliable scores. A composite of those reliable scores, used as the basis for selection decisions, was valid as a predictor of near-term (relative to date-of-hire) training outcomes.

On the other hand, the composite score was not a valid predictor of far-term (2 to 3 years from hire) field training outcomes. Moreover, the fairness analyses suggested that the battery had adverse impact against women, and was likely to have had adverse impact on African-American job candidates. The test battery over-predicted performance in initial ATCS qualification training at the FAA Academy on the basis of gender and race. Adverse impact and over-prediction of training and job performance is commonly reported for tests of cognitive ability similar to the ATCS test battery, such as the General Aptitude Test Battery (GATB) (Hartigan & Wigdor, 1989; Schmidt, 1988; Wigdor & Sackett, 1993). This outcome does not result because scores on the ATCS aptitude test battery mean something different for women and African Americans. The test is not biased in that sense. Rather, the adverse impact and over-prediction of subsequent performance in initial training for both groups results from the interplay of two factors: the lower average scores for African Americans and women relative to white males, and the less-than-perfect validity of the composite test score. As a consequence of these facts, the predicted performance of minorities and women is higher than their actual performance. The practical result is that more women and minorities were hired on the basis of their predicted performance than would have been hired on the basis of their actual job performance.

In conclusion, the written test battery was a valid mass testing tool, with which the FAA could reduce the applicant pool to a smaller, affordable number for more intensive evaluation of their aptitude for the controller occupation. The relative costs of assessment methods must be carefully considered, particularly in view of the substantial numbers of job applicants. For example, the cost of administering the paper-and-pencil ATCS test battery was about $20 per examinee, compared with a cost of about $10,000 per person for initial training at the FAA Academy (Broach & Brecht-Clark, 1993). There was significant financial utility for the agency in using a valid test as the first step in a multiple-hurdle, sequential personnel selection system. Moreover, the test battery was fair, in that test scores over-predicted subsequent training performance of African Americans and women. Overall, the written ATCS aptitude test battery was an inexpensive, practical, valid, fair, and invaluable tool in rebuilding the controller workforce between 1981 and 1992.

AIRCRAFT	ALTITUDE	SPEED	ROUTE
10	7000	480	AGKHC
20	7000	480	BGJE
30	7000	240	AGJE
40	6500	240	CHKJF
50	6500	240	DIKGB
60	8000	480	DIKJE
70	8000	480	FJKID



SAMPLE QUESTION

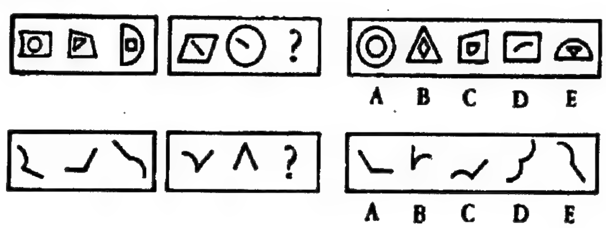
WHICH AIRCRAFT WILL CONFLICT?

A. 60 AND 70
B. 40 AND 70
C. 20 AND 30
D. NONE OF THESE

Figure 2–1: Example Multiplex Controller Aptitude Test (MCAT) item

Symbols

1.
2.



Letters

1) **XCXDXEX** A) **FX** B) **FG** C) **XF** D) **EF** E) **XG**

2) **ARCSETG** A) **HI** B) **HU** C) **UJ** D) **UI** E) **IV**

Figure 2–2: Example Abstract Reasoning (ABSR) test item

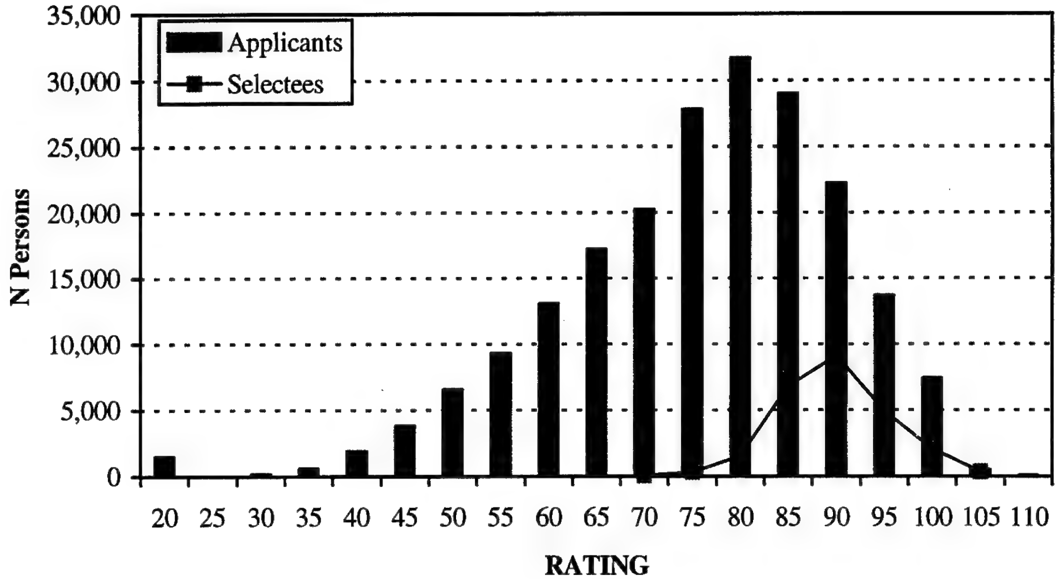


Figure 2–3: Distribution of RATING for examinees and selectees

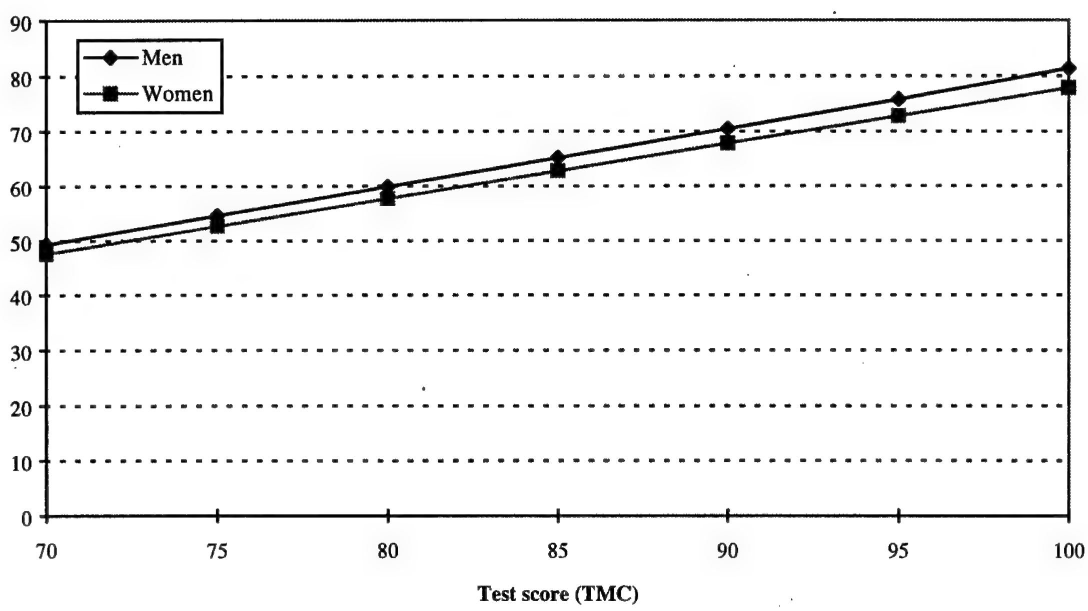


Figure 2–4: Regression of test score (TMC) on FAA Academy score (SCREEN) by gender

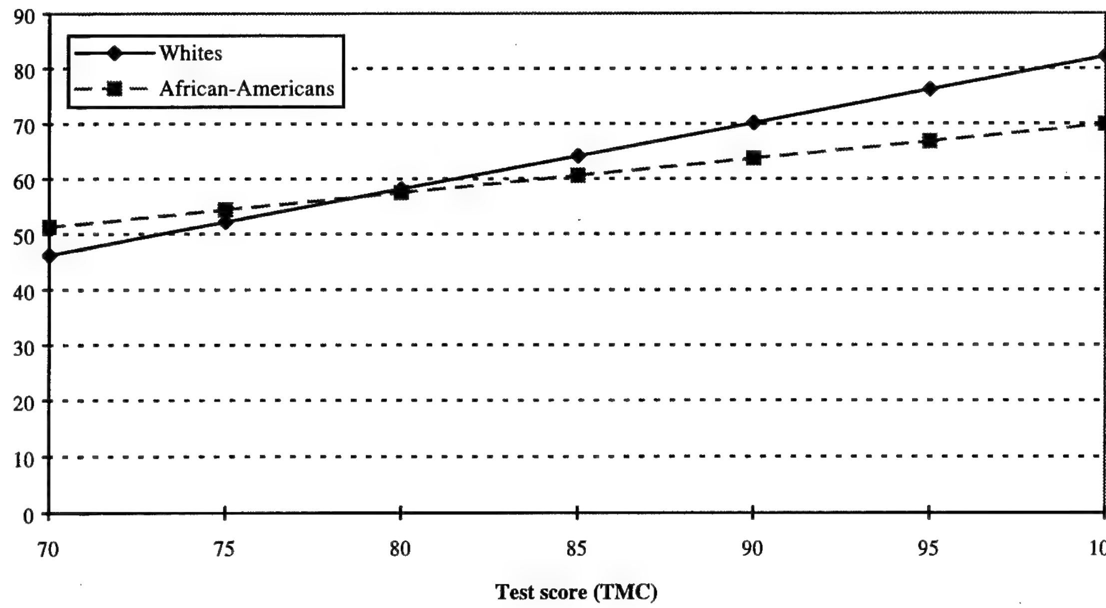


Figure 2–5: Regression of test score (TMC) on FAA Academy score (SCREEN) by race

Table 2–1: ATCS Aptitude test battery scoring

Test	OPM #	Scoring	Weight	N Items
MCAT	510	N Right	2	110
ABSR	157	N Right - (0.25*N Wrong)	1	50
OKT	512	N Right	[a]	80

Note: Extra points awarded as follows for OKT raw scores: 0-51 = 0 extra points; 52-55 = 3 extra points; 56-59 = 5 extra points; 60-63 = 10 extra points; 64-80 = 15 extra points for computation of the civil service rating.

Table 2–2: Correlation matrix structure for regression analyses

	RATING	SCREEN	STATUS
RATING		$r_{e_{(RATING)}}$	$R_{i_{(SCREEN)}}$
SCREEN	r_S		$R_{e_{(SCREEN)}}$
STATUS	r_S	r_S	

Note: Sample correlation matrix structure shown below the diagonal, corrected matrix structure above the diagonal. r_S = sample correlation; $r_{e_{(RATING)}}$ = correlation corrected for explicit selection on RATING; $r_{i_{(SCREEN)}}$ = correlation corrected for incidental restriction in range due to selection on SCREEN; and $r_{e_{(SCREEN)}}$ = correlation corrected for explicit selection on SCREEN

Table 2–3: Descriptive statistics and correlations for 1982-85 Terminal Screen graduates assigned to Terminal OJT

	Sample[a]			Population[b,c]			Correlations[d]		
Variable	*N*	*M*	*SD*	*N*	*M*	*SD*	(1)	(2)	(3)
(1) RATING	2,814	92.31	5.72	99,887	74.93	14.24		.493	-.168
(2) SCREEN	3,174	79.45	5.48	4,686	73.82	11.32	.222***		-.303
(3) STATUS	3,174	88.0%	FPL				-.037	-.146***	
		12.0%	NOT FPL						

Notes: [a]STATUS outcomes for first assigned field facility only as of March 1997 ** $p < .01$, ***$p < .001$
[b]RATING based on CAMI records for examinees tested 1982-85
[c]SCREEN based on Terminal Screen entrants who did not withdraw, 1982-1985
[d]Uncorrected correlations in lower left half, corrected in upper right half.

Table 2–4: Descriptive statistics and correlations for 1982-85 En Route Screen graduates assigned to En Route OJT

	Sample[a]			Population[b,c]			Correlations[d]		
Variable	*N*	*M*	*SD*	*N*	*M*	*SD*	(1)	(2)	(3)
(1) RATING	4,021	92.56	5.37	99,887	74.93	14.24		.502	-.256
(2) SCREEN	4,276	82.02	7.17	4,686	73.82	11.32	.214***		-.351
(3) STATUS	4,276	66.1% FPL					-.047**	-.231**	
		33.9% NOT FPL							

Notes: [a]STATUS outcomes for first assigned field facility only as of March 1997 ** $p \leq .01$, ***$p \leq .001$
[b]RATING based on CAMI records for examinees tested 1982-85
[c]SCREEN based on En route Screen entrants who did not withdraw, 1982-1985
[d]Uncorrected correlations in lower left half, corrected in upper right half.

Table 2–5: Descriptive statistics and correlations for 1986-92 Non-radar Screen graduates assigned to Terminal OJT

	Sample[a]			Population[b,c]			Correlations[d]		
Variable	*N*	*M*	*SD*	*N*	*M*	*SD*	(1)	(2)	(3)
(1) RATING	2,765	93.31	5.15	106,201	76.33	14.67		.458	-.095
(2) SCREEN	3,145	78.28	6.07	12,756	72.26	11.80	.178***		-.137
(3) STATUS	3,298	95.0% FPL					-.027	-.071***	
		5.0% NOT FPL							

Notes: [a]STATUS outcomes for first assigned field facility only as of March 1997 ** $p \leq .01$, ***$p \leq .001$
[b]RATING based on CAMI records for examinees tested 1982-85
[c]SCREEN based on Non-radar Screen entrants who did not withdraw, 1982-1985
[d]Uncorrected correlations in lower left half, corrected in upper right half.

Table 2–6: Descriptive statistics and correlations for 1986-92 Non-radar Screen graduates assigned to En Route OJT

	Sample[a]			Population[b,c]			Correlations[d]		
Variable	*N*	*M*	*SD*	*N*	*M*	*SD*	(1)	(2)	(3)
(1) RATING	3,969	93.79	5.06	106,201	76.33	14.67		.493	-.129
(2) SCREEN	4,449	80.26	5.89	12,756	72.26	11.80	.192***		-.247
(3) STATUS	4,732	77.3% FPL 22.7% NOT FPL					-.014	-.126***	

Notes: [a]STATUS outcomes for first assigned field facility only as of March 1997 ** $p \leq .01$, *** $p \leq .001$
[b]RATING based on CAMI records for examinees tested 1982-85
[c]SCREEN based on Non-radar Screen entrants who did not withdraw, 1982-1985
[d]Uncorrected correlations in lower left half, corrected in upper right half.

Table 2–7: Civil service RATING validity in predicting FIELD TRAINING outcome by sample, based on corrected correlations

	Sample				
Period	FAA Academy	Field OJT	*R*	β-RATING	β-SCREEN
1982-85	Terminal Screen	Terminal	.304***	-.025	-.291***
1982-85	En Route Screen	En route	.363***	-.107***	-.297***
1986-92	Non-radar Screen	Terminal	.142***	-.041	-.118***
1986-92	Non-radar Screen	En route	.247***	-.010	-.242***

*$p \leq .05$, **$p \leq .01$, ***$p \leq .00$

Table 2–8: Adverse impact analysis by gender based on OPM eligibility codes

	Sex		
OPM Eligibility	Males	Females	Row totals
Eligible	69,056 (58.1%)	14,564 (42.0%)	84,070
Failed test	49,902 (41.9%)	20,077 (58.0%)	69,979
Column totals	118,985	34,641	53,599

Notes: Percents are column percentages

CHAPTER 3:

FAA ACADEMY AIR TRAFFIC CONTROL SPECIALIST SCREENING PROGRAMS AND STRIKE RECOVERY

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In 1976, the Federal Aviation Administration (FAA) implemented screening programs for Air Traffic Control Specialists (ATCSs) at the FAA Academy which, in combination with a paper-and-pencil selection test, provided a robust two-stage selection system used in recovery from the 1981 Professional Air Traffic Controller Organization (PATCO) strike. The purpose of the present paper is to review data from the FAA Academy screening programs with regard to their role in the FAA strike recovery efforts, as well as the evolution of the programs in the post-strike years. Data are presented for pass rates, demographics, and evidence of validity of the programs.

At the time of the 1981 Professional Air Traffic Controller Organization (PATCO) strike, the Federal Aviation Administration (FAA) selected Air Traffic Control Specialists (ATCSs) through a two-stage process (Della Rocco, Manning, & Wing, 1990). The first stage was the Office of Personnel Management (OPM) written air traffic control (ATC) test battery (Broach, this volume). The second stage was a FAA Academy initial qualification course. This two-stage process provided a robust foundation for recovery of the controller workforce in the wake of the firing of the striking ATCSs. The purpose of the present paper is to review the FAA Academy screening programs with regard to their role in the FAA recovery from the strike, as well as the evolution of the programs in the post-strike years. Data are presented for pass rates, demographics, and validity of the programs.

Background

The FAA has conducted research on the selection of ATCSs since the 1950s (Collins, Boone, & VanDeventer, 1984). Written aptitude tests for the occupation were implemented as early as 1964 and were administered nation-wide. Despite the increased validity of the written Civil Service Commission (CSC) selection tests over the previous system based on prior experience alone, the high occupational attrition rates were a concern through the late 1960s and into the early 1970s. In 1974, for example, the failure rate was about 43% for en route trainees and 38% for terminal trainees (Henry, Ramrass, Orlansky, Rowan, String, & Reichenbach, 1975). This training attrition typically occurred two to three years into an individual's career (Manning, 1991). During the early 1970s, several groups examined the FAA's air traffic training and selection process (Corson, 1970; Henry et al., 1975; Committee on Government Operations, 1976). The reports recommended the development of a validated, standardized, and centralized pass/fail training program, designed to screen persons who lacked sufficient potential to become fully certified ATCSs early in their career (Boone, 1984). The FAA committed to the development of screening programs, which would follow successful performance on the written CSC (renamed Office of Personnel Management in 1978) air traffic test battery (Boone, 1984).

Description of FAA Academy Screening programs

Pre-strike Screening programs

In 1976, the pass/fail FAA Academy initial qualification courses were implemented. They were based on non-radar air traffic control procedures. Separate courses existed for the two career options, En Route and Terminal. Entrants were assigned to an option based upon agency staffing needs. The screening programs evolved from training previously administered by the FAA Academy. The courses were designed to assess the aptitude of an individual with no prior knowledge of the

occupation. These screening courses were the equivalent of a miniaturized training-testing model of selection (Manning, Kegg, & Collins, 1989; Della Rocco, Manning, & Wing, 1990).

The Terminal and En Route Screen programs contained two pass/fail phases covering (1) an introduction to aviation and air traffic control and (2) procedures for non-radar control of air traffic in the airspace relevant to each option (Boone, 1984). The first pass/fail segment was strictly academic and covered topics such as principles of flight, meteorology, air traffic service and the National Airspace System. However, it was the non-radar procedures phase of training that identified the candidates with less chance of succeeding in the occupation. The non-radar phase for both options included academics, laboratory simulation problems, and the Controller Skills Test (CST). During the academic classroom training, entrants were taught the rules and principles of non-radar ATC. Students received a score from this academic training which was included in the final non-radar phase score. During the laboratory training, entrants were required to apply the rules and principles learned in the classroom to air traffic simulation problems. Each entrant performed non-radar controller job tasks in one or two thirty-minute scripted scenarios daily. An individual instructor was assigned to each student for each scenario. Following the scenario, the instructor reviewed the student's performances and provided feedback on errors as well as correct application of the rules and scenario scores. Instructors assigned a technical assessment (number of errors), as well as an instructor assessment (subjective evaluation of student performance) for each scenario. The laboratory scenarios were structured to escalate in complexity. Five of six of the final laboratory problems were graded and counted in the final score. The CST was the final test administered in the non-radar phase. It was a timed, paper-and-pencil, multiple-choice assessment of the student's ability to apply non-radar ATC rules and procedures. A final composite score of at least 70 (out of a possible score of 100) was required to pass the non-radar phase. Failure to achieve a composite score of 70 resulted in removal from the ATCS job. Although the En Route and Terminal Screen programs were modified over the years, the basic structure remained much the same between 1976 and 1985.

At the time of the strike in 1981, the En route and Terminal Screen programs had effectively achieved the goal of reducing field attrition (Manning, 1991). Between 1971 and 1975, field attrition in both options averaged 41%. Following the implementation of the screening programs between 1976 and 1981, FAA Academy attrition rates were 29% and subsequent field attrition was cut to 8%. Thus, within the first few months of appointment to the occupation, the FAA Academy programs screened out most of those individuals who lacked sufficient potential to become fully certified ATCSs. The pass rate was 67% for En Route Screen entrants and 74% for Terminal, with an overall average of 70%. Of historical note, subsequent to the strike, a new Office of Personnel Management (OPM) test battery was implemented, replacing the previous CSC battery (Broach, this volume; Collins, Boone, & VanDeventer, 1984).

A key feature of the 1976 effort was to implement a research database system to document and monitor the effectiveness of the program. The database was established at the Civil Aeromedical Institute (CAMI). Data were collected on all FAA Academy entrants. Planning for the second-stage pass/fail screening programs was influenced by requirements identified by publication of the original *Uniform Guidelines on Employee Selection Procedures* in 1966 (Boone, 1984). The database provided a source for monitoring compliance with those guidelines. In 1984, the CAMI tracking database was established to track FAA Academy graduates through Full Performance Level (FPL; Manning, this volume). This database provided criterion measures for program validation.

Strike recovery, 1981-1985

By the time of the strike in 1981, the FAA had five and a half years of experience using the En Route and Terminal initial qualification courses as screening programs. In addition, data on all entrants had been collected in the research database. Thus, the system was in place to select and monitor the progress of ATCS candidates, including individuals who had no knowledge of the occupation. The FAA Academy only needed to gear up to manage the increased student load resulting from the strike recovery effort. Prior to the strike, 8,262 candidates (4,138 En Route and 4,124 Terminal) entered the programs in the approximately five and a half year period between January 1976 and August 1981 (Manning, Kegg, & Collins, 1988). Following the strike, 13,533 candidates entered during the four-year period between August 1981 and September 1985. The number of En Route Screen program entrants more than doubled to 8,536, while the number of Terminal Screen program entrants rose approximately 20% to

4,997. The structure of the screening programs was not changed to accommodate the strike recovery (Boone, 1984).

Following the strike, the pass rates in both the En Route and Terminal Screen programs declined (Manning, Kegg, & Collins, 1989). Between August 1981 and September 1985, entrants to the En Route Screen program had an average pass rate of 52%, compared with the pre-strike pass rate of 67%. En Route Screen failures represented 36% and withdrawals represented 12% of the total 8,536 entrants. In the Terminal Screen program, the post-strike pass rate was 68%, compared with the pre-strike rate of 74%. Terminal Screen program entrant failures represented 26%. The Terminal Screen program withdrawal rate was 6% of total entrants.

Examination of the demographic data from pre- and post-strike FAA Academy entrants (Collins, Manning & Taylor, 1984) revealed a shift in the proportion of entrants reporting prior ATC experience. Prior to the strike, 70% of FAA Academy entrants reported either aviation or air traffic control experience prior to entry. After the strike, nearly two-thirds of the entrants had no prior aviation-related experience. FAA Academy pass rates were higher for the group of entrants with prior ATC experience than entrants with no prior experience (Collins, Manning, & Taylor, 1984). The decline in the percentage of entrants with previous ATC experience, particularly prior military controllers, may have affected the pass rates. Because the initial qualification courses were designed for individuals with no prior experience, this shift in demographics was manageable. Table 3-1 presents demographics for each of the time periods examined in this paper.

The "Non-radar Screen," 1986-1992

Changes to the program during the first decade involved such modifications as alterations in scoring and the number of graded problems (Manning, Kegg, & Collins, 1989). In 1985, however, a major change was made to consolidate the En Route and Terminal Screen programs into a single FAA Academy program, the "Non-radar Screen." Analyses of the longitudinal databases had begun to point to areas in which the screening effectiveness and cost benefits could be enhanced. Because the En Route Screen program was found to better correlate with measures of field success such as supervisor's ratings (VanDeventer, 1981), than the Terminal program, the En Route Screen program was selected as the basis for the Non-radar Screen (Manning, Kegg, & Collins, 1989). Some changes were made to the weights assigned to the scores on various components to achieve a projected 60% pass rate. The change to using a single screening course meant that students were not assigned to an option or facility until they completed the Non-radar Screen and their FAA Academy scores could be used to place graduates. It was anticipated that assigning students with higher aptitude to more complex facilities would result in further reductions in field training attrition. In addition, the Non-radar Screen was re-sequenced in Fiscal Year 1989 to be the first course completed by FAA Academy students. It was anticipated that by postponing the three-week, academic phase of training that originally preceded the pass/fail Non-radar Screen, the training costs associated with people who would fail or withdraw from the screen would be avoided through the re-sequencing. The nine-week Non-radar Screen was implemented in October 1985 (FY 1986) and continued through the January 1992 entering class. Non-radar Screen pass rates were 56.6% for 14,392 entrants. Failures represented 32.2%, and 11.2% withdrew.

Validity Evidence

Over the years, several studies examined various measures to assess the predictive validity of the FAA Academy screening programs. These included attrition rates, supervisor ratings, and field training progress. VanDeventer (1981) reported a correlation of .56 (adjusted for explicit restriction in range on FAA Academy score) between the FAA Academy final composite score and the field supervisor's rating for the en route option. Manning, Della Rocco, and Bryant (1989) used field-training status as well as field instructor rating as criterion measures. They reported adjusted correlations between the FAA Academy composite score and instructor ratings of .46 and .30 for the En Route and Terminal Screen programs, respectively. In the first report of data on Non-radar Screen graduates, Della Rocco, Manning, and Wing (1990) reported an adjusted correlation of .44 between FAA Academy composite score and field training status of graduates assigned to the En Route option. In 1994, Broach and Manning reported evidence that the Non-radar Screen was a valid predictor of FAA Academy radar training performance.

To evaluate the final status of the Non-radar Screen program, correlations between the FAA Academy composite score and field training status from the CAMI tracking database for FAA Academy graduates who entered as competitive hires were examined. Field status was a variable that identified ATCSs in their first field

facility as follows (Manning, 1991): 1 = *Reached Full Performance Level*, 2 = *Still in training (Developmental)*, 3 = *Switched facilities*, 4 = *Switched options*, or 5 = *Failed.* Data for individuals who separated from the occupation for reasons unrelated to performance were excluded. The correlation between Non-radar Screen scores and field status in the en route option was -.12 (N = 3,484, $p \leq .001$). Adjusted for explicit restriction in range on the FAA Academy score (Thorndike, 1949), this correlation was -.25. The correlation between Non-radar Screen scores and terminal field status was -.08 (N = 2,505, $p \leq .001$). The correlation, adjusted for range restriction, was -.17. Figures 3-1 and 3-2 present the relationship between FAA Academy Score and attainment of Full Performance Level (FPL) field status at the first facility assignment for en route and terminal options, respectively.

Evaluation of Potential Adverse Impact

The screening programs were monitored on an ongoing basis for the success of minorities and women to determine compliance with the *Uniform Guidelines on Employee Selection Procedures* ("*Uniform Guidelines*;" Equal Employment Opportunity Commission, 1978). The *Uniform Guidelines* provided a "rule of thumb" for assessing adverse impact in protected groups to determine if the procedure differentially selected one group over another. An impact ratio is calculated for each target group's pass rate by the pass rate of the group with the highest rate (typically the non-minorities). By the rule of thumb, if the impact ratio is greater than or equal to .80, the program is usually assumed to demonstrate no adverse impact. The En Route and Terminal Screen programs were found to have adverse impact against African Americans in 1984-85 (Manning, Kegg, & Collins, 1989). Part of the rationale for modifying the FAA Academy program scoring was to reduce the adverse impact. Initial assessments of the Non-radar Screen program for the January 1986-January 1988 entrants revealed an impact ratio of .832, an improvement over the old En Route Screen program. However, for the final two and a half years of the program the ratio for African Americans fell below the .80 rule of thumb. A review of impact ratios by fiscal year revealed the following: .55 for FY 90, .60 for FY 91, and .52 for the final classes during FY 92.

Discussion

The two-stage ATCS selection process involving the Office of Personnel Management (formerly Civil Service Commission) testing and FAA Academy screening, was a very robust and predictable system that served the agency well as a gateway to a safety-critical career. The experience with the two-stage system, as well as a database for assessing system performance, provided a foundation for recovery from the PATCO strike in 1981.

The correlations in the present analyses between Non-radar Screen scores and field status were lower than those previously reported. One possible reason was that field training was modified during the late 1980s (Manning, 1991). The influx of a large number of developmentals at the lower-staffed facilities would certainly have led to some adjustments in the processes needed to provide instruction and supervision for the on-the-job training provided to the developmentals. To date, adequate criterion measures have been a problem in establishing the validity of the ATCS screening programs (Della Rocco, Manning, & Wing, 1990; Broach & Manning, 1997). The decline in impact ratios may have resulted from the direct hire authority granted to the FAA by OPM during the late 1980s (Della Rocco & Sawyer, 1990). A higher percentage of applicants with lower OPM scores were hired with a predictable outcome of lower FAA Academy pass rates.

In March 1992, the final classes graduated from the FAA Academy Non-radar Screen program, marking the end of an era for air traffic control specialist selection procedures, which had lasted nearly two decades. The system succumbed to various pressures, such as calls to shorten and reduce the costs of the second stage screen (Aerospace Sciences, Inc., 1991), as well as a compromise of the OPM test battery (Manning, 1991). In the Screen's miniaturized training-testing program, individuals with no prior knowledge of the ATC occupation demonstrated that they could separate airplanes in laboratory simulations prior to continuing in the career field. The FAA is currently examining the possibility of using a computerized test battery to replace the former selection systems. It remains to be seen whether or not a cognitive test battery, which measures component skills and abilities in combination with noncognitive measures, can, in fact, effectively replace the work sample model employed in the screening programs. The history of ATCS selection certainly suggests that a robust system can be developed to supply a steady flow of qualified applicants.

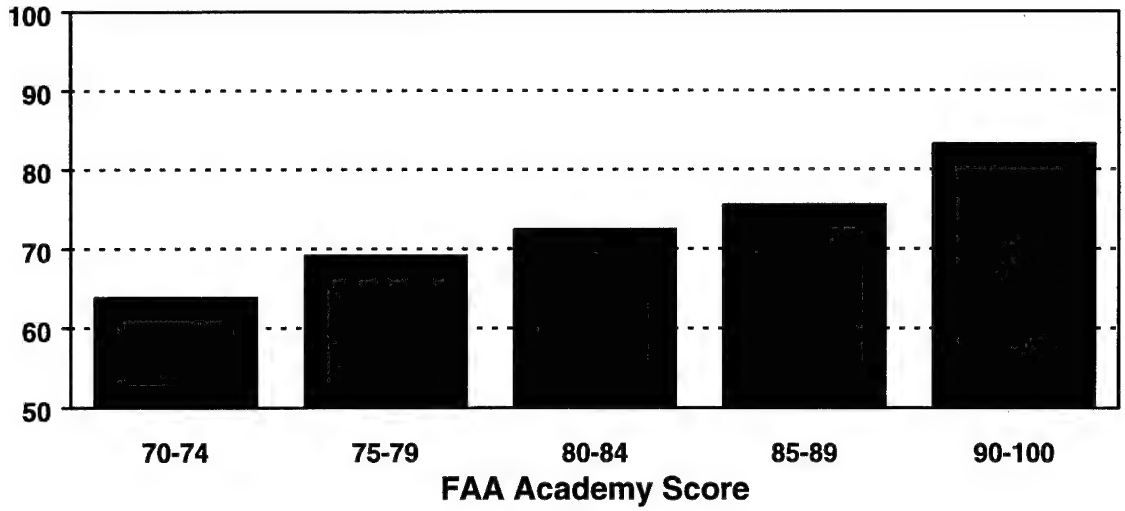

Figure 3–1: Percent achieving en route FPL field status by FAA Academy score

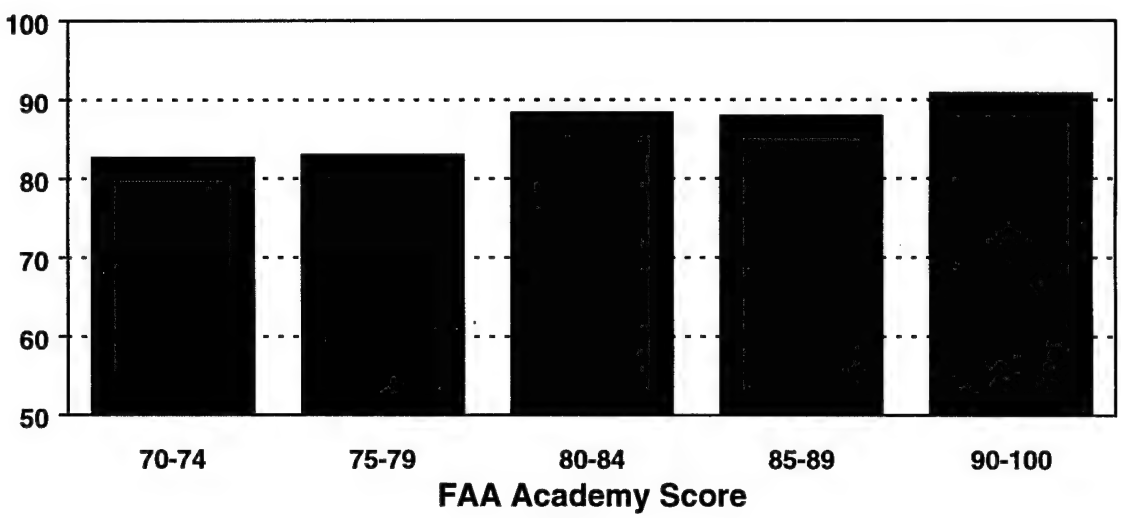

Figure 3–2: Percent achieving terminal FPL field status by FAA Academy score

Table 3–1. Demographic profile of FAA Academy entrants

	Pre-Strike 1976-1981 (*N*=6,059)	**Post-Strike 1981-1985** (*N*=13,533)	**Screen 1986-1992** (*N*=14,392)
Experience			
No related experience	30%	65%	79%
Aviation Only	20%	17%	5%
ATC Operations	50%	18%	16%
Average Age	26.5	26.5	26.2
Education			
High School Only	14%	9%	11%
Some College	48%	44%	54%
College Degree	38%	47%	35%
Gender			
Male	83%	85%	80%
Female	17%	15%	20%
Minority Status			
Minority	13%	8%	12%
Non-Minority	87%	92%	88%

CHAPTER 4:

AIR TRAFFIC CONTROL SPECIALIST FIELD TRAINING PROGRAMS, 1981-1992

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This paper presents statistics describing the status of graduates from the FAA Academy ATCS screening programs (Della Rocco, this volume) in subsequent field training programs. Of the 8,160 FAA Academy graduates assigned to En Route facilities between 1981 and 1992, 71.6% were certified as full performance level (FPL) controllers by June 1995. Of the 6,417 FAA Academy graduates assigned to Terminal facilities between 1981 and 1992, 83.8% were certified as FPL by June 1995. The data indicate that the FAA successfully implemented and executed a large-scale field training program to rebuild the controller workforce following the 1981 PATCO strike.

When approximately 10,400 of 17,000 air traffic controllers were fired as a result of the 1981 Professional Air Traffic Controller Organization (PATCO) strike, the FAA was required to hire and train their replacements. Other papers in this volume describe the processes for recruiting and selecting Air Traffic Control Specialist (ATCS) trainees. This paper presents statistics describing their status in ATCS field training programs. The statistics were extracted from a data base developed at the FAA Civil Aeromedical Institute (CAMI) after the 1981 strike. The data were used to track developmental progress in field training (per FAA Order 3120.22A, 1985) and provide feedback about the effectiveness of the selection procedures. The complete field training data base included information about those who graduated from the FAA Academy and certain other types of trainees (e.g., military hires) regarding overall success rates in field training as well as pass rates and times to complete specific phases of field training. Only field training status for FAA Academy graduates will be described here.

Background

Successful graduates of the FAA Academy in Oklahoma City entered a multi-phase training program administered at their assigned field facility. The content of this training depended on their option (En Route or Terminal) and facility assignment. For several years after the strike, trainees assigned to the en route option (that is, Air Route Traffic Control Centers or ARTCCs) took equivalent types of training that differed only according to their area of specialization. Each ARTCC partitions their airspace into between 4 and 8 areas of specialization. A developmental who began training at an ARTCC was assigned to only 1 of these areas and was required to certify that he or she could perform air traffic control (ATC) duties on all sectors (or sub-partitions of airspace) within that area before being allowed to control traffic without supervision. After an initial phase of training in which trainees demonstrated their knowledge of the area of specialization by learning the maps for all sectors, they took a series of training phases designed to prepare them for certification on 3 types of ATCS duties (those of the assistant controller, radar associate/non-radar controller, and radar controller) in their area. Training for one set of ATC duties was typically completed on all sectors before beginning training for the next set of duties. Training phases conducted in classroom, laboratory, and OJT (on-the-job training) environments were reported separately.

The content of training at terminal facilities depended on the ATC positions used at each type of facility. Non-approach or Visual Flight Rules (VFR) facilities conducted training on Flight Data, Clearance Delivery, Ground Control, and Local Control positions. Limited radar facilities conducted an additional phase for the Non-radar position. Trainees at facilities that had both non-approach and radar functions completed all the above phases along with an additional phase of training for the Radar position. Some facilities were split administratively so that controllers worked in either the tower cab or the radar room but not in both. In this case, they were required to take only phases of training relevant to their specific duties. Each phase of

terminal training included classroom, laboratory, and OJT components. Individuals who completed their training at one terminal facility, became Full Performance Level (FPL) controllers, then transferred to another facility, were required to complete all phases of training relevant to their new facility, even if they had already completed the same phases at their previous facility. This process was required to accommodate learning how to perform ATC duties in a new airspace at a new facility which may be different than the way those duties were performed in the airspace at the previous facility.

Sample Demographics

As described by Della Rocco (this volume), the demographics of candidates entering the FAA Academy screening programs changed between 1981 and 1992, so it can be expected that the demographics of those entering field training would reflect those changes. Table 4-1 compares demographics for graduates of the 1981-1985 En Route Screen program (hereafter referred to as 'the En Route Screen'), the 1981-1985 Terminal Screen program (hereafter referred to as 'the Terminal Screen') and the 1986-1992 Non-radar Screen program (hereafter referred to as 'the Non-radar Screen').

Differences in demographics can be seen between groups of graduates of the two FAA Academy programs conducted at the same time as well as groups that graduated at different times. The percentage of males graduating from the En Route Screen was slightly higher (88%) than was the percentage graduating from either the Terminal Screen (83%) or from the Non-radar Screen program (82%). The percentage of non-minorities was highest among En Route Screen graduates (95%), lower among Terminal Screen graduates (about 92%), and lowest among graduates of the Non-radar Screen (about 91%). Most trainees graduating from the FAA Academy entered through the competitive hiring process. Over 90% of En Route Screen graduates were competitive hires, while about the same percentage of Terminal and Non-radar Screen graduates (82.4% and 82.7%, respectively) were hired competitively. Of those for whom the amount of education was known, about the same percentage of En Route and Terminal Screen graduates had a college degree (46.7% and 48.4%, respectively) while fewer Non-radar Screen program graduates had a college degree (about 35%).

Field Training Outcomes

Developmental controllers who entered field training after the 1981 strike were required to complete each phase of training successfully in a specified period of time to avoid removal (FAA Order 3330.30C, 1984). If removed from training, their disposition depended on the type of facility to which they were assigned and the amount of training they completed prior to removal. Generally, en route trainees who completed part of their radar training prior to removal were eligible for reassignment to a terminal facility of level 3 or below. En route trainees completing initial radar associate training prior to removal were eligible for reassignment to a non-radar facility or a Flight Service Station (FSS). Those who completed the classroom portion of radar associate training were eligible for reassignment to an FSS. A somewhat similar reassignment structure existed for terminal trainees. Those assigned to a level 4 or 5 facility who failed to complete training on local control were eligible for reassignment to a level 1 or 2 non-radar or limited radar facility. Those who failed to complete radar training were eligible for reassignment to a lower level non-radar facility or level 2 limited radar facility. Those who failed to complete radar training after certifying on at least 1 radar position were eligible for reassignment to a lower level terminal facility.

A variable was developed to describe the status in field training for trainees at their first facility assignment after FAA Academy graduation. Use of this variable assumed that a developmental who transferred to another facility before reaching FPL status did so because of failure to complete the training program. Exceptions to this assumption were made for those that we knew had transferred or separated from the occupation for reasons unrelated to failure and for en route trainees who switched to another center before reaching FPL status because this type of transfer was typically unrelated to training performance. However other transfers, for example, from en route to a lower level terminal facility or to a FSS, or from a terminal radar facility to a lower level terminal facility or a FSS, were assumed to be related to training failure.

The values of the variable indicating field training status are shown in Table 4-2. Facility switches within the terminal option were typically from a higher activity facility to a lower activity facility and typically resulted from failure to complete training. On the other hand, facility switches within the en route option were not considered failures because en route failures typically

resulted in reassignments across options and not to facilities within the same option. Thus, it was considered appropriate to categorize field training status separately for each option.

Changes in Field Training Status Over Time

Tables 4-3 and 4-4 show status in en route and terminal field training by the FAA Academy program attended. About 10% more graduates of the Non-radar Screen program reached FPL status than did graduates of either the En Route or Terminal Screens. Table 4-3 also shows that a slightly higher percentage of Non-radar Screen graduates (about 9%) than En Route Screen program graduates (about 7%) transferred to terminal facilities. However, the percentage of transfers to FSS as well as failures was lower for Non-radar Screen graduates than for graduates of the En Route Screen. Also, a small percentage of Non-radar Screen program graduates had not completed their training when these analyses were conducted in April of 1997.

Graduates of the Non-radar Screen program who entered terminal facilities had a lower percentage of facility switches, FSS transfers, and failures than did graduates of the Terminal program. Additional analyses of field training status by year of graduation showed a systematic increase in rates of reaching FPL over time. For FAA Academy graduates entering en route field training, rates of reaching FPL status were 63–66% for 1982-84 classes, 70–75% for 1985-88 classes, and 80–83% for 1989-91 classes. Only about 72% of 1992 FAA Academy Non-radar Screen program graduates in en route field training reached FPL status as of April 1997, but an additional 13% of that group are still in training. (Although previous studies found that the average time to reach FPL status in the En Route option is about 3 years [e.g., Manning, Della Rocco, & Bryant, 1989], some individuals were identified who remained in training for 6 years or more.) For those entering terminal field training, rates of reaching FPL status were 76–82% for 1982-84 classes, 85–89% for 1985-89 classes, and 89–92% for 1990-92 classes.

The causes of observed changes in rates of attrition from training over time are difficult to determine because modifications occurred in the content of both the FAA Academy Non-radar Screen and in field training. The Non-radar Screen program, introduced in 1986, contained less information about weather and aircraft performance characteristics than did the former Terminal and En Route Screens. Subsequent training (both at the FAA Academy and in the field) was eventually modified to incorporate those lessons. It might be expected that removing lessons from the Non-radar Screen program would result in an increased training attrition rate. However, training attrition rates actually decreased for Non-radar Screen graduates. Thus, changes in the content of the Non-radar Screen program were probably not responsible for the changes in field attrition rates for Non-radar Screen program graduates.

Another factor that may have reduced attrition from en route field training is a change in the content of the field training program. en route field training was changed at some facilities to decrease the emphasis on non-radar air traffic control duties and increase the emphasis on radar associate duties. Although a certain amount of non-radar training had been required for all trainees, it was not directly applicable to the ATC duties that some controllers actually performed. It was determined that the amount of non-radar training provided should be proportional to the type of control that would be conducted by the developmental controllers. This change, which made the training more relevant, may also have resulted in a reduction in the attrition rate because a high percentage of failures could be traced back to non-radar training.

Some en route facilities also changed the order in which training phases were administered so that training for all control activities (radar associate and radar control) was completed for a pair of sectors before moving on to any other sectors. Additionally, informal, undocumented changes occurred in the administration of field training as a result of a decrease in the number of people entering the facilities after about mid-1983. Prior to the strike, numbers of trainees entering the system (701 in 1980 and 300 before August 1981) were much lower than the first 2 years after the strike (3416 in 1982 and 1720 in 1983). Lower rates of failure and transfers to other facilities might have occurred for trainees who graduated from the FAA Academy after 1983 because their OJT instructors had more time to spend with individual trainees.

Field Training Status and Demographics

Tables 4-5 and 4-6 show field training status for each option by the demographic variables described above. Table 4-5 shows field training status by demographic groups for those entering en route facilities. Rates of reaching FPL status were approximately equivalent for male (71.4%) and female (72.5%) en route trainees. African-American trainees had lower rates of reaching FPL (about 63%) than did non-minorities (about 72%),

but were slightly more likely to be transferred to an FSS (about 11%) than were non-minority trainees (6%). Other minority groups had rates of reaching FPL status that were the same or better than were those for non-minorities. FAA Academy graduates who were non-competitive and Pre-Developmental entrants were less likely to reach FPL status (about 62% and 55%, respectively) than were competitive entrants (about 73%). FAA Academy graduates from the Airway Science program had a higher rate of reaching FPL (95%) than did competitive entrants but their overall numbers were low. Those with any type of college degree were somewhat less likely to become FPL (81%) than were those without a college degree (86%).

Table 4-6 shows similar statistics for terminal trainees. Females were somewhat less likely to reach FPL status (80%) in a terminal facility than were males (about 85%) and were more likely than males to switch facilities within the terminal option (11% as compared with 7%). Hispanic (80%), and to a greater extent, African-American trainees (77%) were less likely than were non-minority trainees (84%) to reach FPL status. Of those who failed to reach FPL status, Hispanics were more likely to be reassigned to another terminal facility (about 13%) than were non-minorities (about 8%) and African Americans (13%) were more likely to fail and separate from the occupation than were non-minorities (about 7%). FAA Academy graduates who went through Airway Science programs were more likely to reach FPL (95%) than were competitive entrants (85%). Non-competitive entrants (75.5%) and Pre-Developmental entrants (72%) were less likely than were competitive entrants to reach FPL status. Again, those with a college degree were less likely to reach FPL status (81%) than were those without a college degree (86%).

Time Until Occurrence of Training Attrition

Table 4-7 shows the average time for attrition from training to occur by option and type of FAA Academy program. Training attrition at the first facility occurred between about 1 year and more than 2 ½ years after FAA Academy graduation. It appears that en route trainees who failed to complete training were retained at their facility longer than were terminal trainees. However, the categories included in the Type of Attrition variable were not the same for the two options so a direct comparison is not appropriate. The amount of time until attrition from training in the terminal option was the same or shorter for Non-radar Screen graduates than for graduates of the Terminal Screen for all types of attrition except failure. On the other hand, the amount of time to attrition from training in the en route option was consistently longer for Non-radar Screen graduates than for graduates of the En Route Screen program, regardless of type of attrition.

Conclusions

The administration of ATCS field training programs was affected by changes that occurred during the years after the 1981 controller strike. In the early 1980s, there was an influx of new trainees that tested the capabilities of the training system. Not only did a large number of trainees need to use the limited lab space at the same time, there were also few instructors available to provide OJT. The numbers of FAA Academy graduates entering field training reduced after 1983, but it took several years for the large group of 1981-83 trainees to make it through the bottlenecks in the training system to complete training. It is likely that FAA Academy graduates who entered training later received more attention than did those who entered training immediately after the strike. Data regarding the length of time until attrition occurred and rates of reaching FPL status support this interpretation.

A more efficient second-stage selection procedure was introduced at the FAA Academy in the fall of 1985. At the same time, programs to recruit under-represented groups resulted in increases in the percentages of women and minorities entering field training. Women succeeded in training in about the same proportion as men, while minorities had somewhat lower rates of reaching FPL than did non-minorities. The overall result should be an increase in the diversity of the ATC workforce. Changes were made in the content of en route field training programs after about 1985. These changes resulted in a training program that better targeted specific skills performed on the job.

The percentage of trainees reaching FPL status increased for those entering field training during the late 1980s. Because so many changes occurred in both selection procedures and training programs at about the same time, we cannot determine why the success rates increased. However, the data suggest that the FAA successfully accomplished the requirement to train a substantial number of new air traffic controllers to replace the fired controllers.

Table 4–1: Demographics of FAA Academy program graduates

	FAA Academy Program							
	En Route Screen 1981-85		Terminal Screen 1981-85		Non-radar Screen 1986-92		Group Total	
	N	%	N	%	N	%	N	%
				Gender				
Male	3,928	88.0	2,814	83.0	6,683	82.0	13,425	83.9
Female	535	12.0	576	17.0	1,465	18.0	2,576	16.1
Total	4,463	100.0	3,390	100.0	8,148	100.0	16,001	100.0
				Minority Status[b]				
Amer. Indian	19	.4	17	.5	47	.6	83	.5
Asian-Pac.	28	.6	32	1.0	98	1.2	158	1.0
African-Amer.	81	1.8	119	3.5	339	4.3	539	3.4
Hispanic	86	2.0	73	2.2	254	3.2	413	2.6
Non-Minority	4,194	95.1	3,117	92.8	7,182	90.7	14,493	92.4
Total	4,408	100.0	3,358	100.0	7,920	100.0	15,686	100.0
				Entry Type[c]				
Competitive	4,046	92.7	2,772	82.4	6,635	82.7	13,453	85.4
Airway Science	8	.2	4	.1	75	.9	87	.6
Pre-Devel.	57	1.3	113	3.4	155	1.9	325	2.1
Coop. Ed.	34	.8	49	1.5	422	5.3	505	3.2
ATA	43	1.0	94	2.8	564	7.0	701	4.5
VRA	34	.8	41	1.2	21	.3	96	.6
Noncompetitive	134	3.1	237	7.0	86	1.1	457	2.9
Former ATC	10	.2	54	1.6	61	.8	125	.8
Former GS-9					2	.0	2	.0
Total	4,366	100.0	3,364	100.0	8,021	100.0	15,751	100.0
				Education[d]				
No coll. degree	2,346	53.3	1,648	51.6	5,230	64.9	9,224	59.0
College degree	2,053	46.7	1,544	48.4	2,824	35.1	6,421	41.0
Total	4,399	100.0	3,192	100.0	8,054	100.0	15,645	100.0

Notes: [a]All percents are for columns within grouping.
[b]Minority status: Amer. Indian = American Indian/Alaskan.; Asian-Pac. = Asian-Pacific Islander.
[c]Entry Type: Airway Science = graduate of accredited Airway Science program. Pre-Devel. = participated in FAA Pre-Developmental Program; Coop. Ed. = Cooperative Education Program; ATA = former Air Traffic Assistant (GS-2154 or GS-2102); VRA = hired under Veterans Readjustment Act; Former ATC = previously graduated from FAA Academy and failed field training; Former GS-9 = previously hired under GS-9 military hire program and failed field training.
[d]Education: No coll. degree includes high school graduates and candidates with some college hours but no degree. College degree includes those with a bachelor's or higher degree.

Table 4–2: Coding of field training status at first facility by option

Status	Option: En Route	Option: Terminal
1	FPL	FPL
2	Developmental	Developmental
3	Terminal transfer	Facility switch
4	FSS transfer	FSS transfer
5	Fail	Fail

Note: FPL, reached Full Performance Level. Developmental, still in training at first facility. Terminal transfer, transferred to Terminal facility before reaching FPL status. Facility switch, transferred to another Terminal facility before reaching FPL status. FSS transfer, transferred to FSS facility before reaching FPL status. Fail, failed training and separated from ATC occupation.

Table 4–3: En Route field training status by FAA Academy program

	FAA Academy Program[a]					
	En route Screen 1981-85		Non-radar Screen 1986-92		Group Total	
Field Training Status[b]	N	%	N	%	N	%
FPL	2,758	65.7	3,405	77.2	6,163	71.6
Developmental			48	1.1	48	.6
Terminal transfer	289	6.9	393	8.9	682	7.9
FSS transfer	424	10.1	115	2.6	539	6.3
Fail	728	17.3	450	10.2	1,178	13.7
Group Total	4,199	100.0	4,411	100.0	8,610	100.0

Note: [a]All percents are column percents.
[b]En Route field training status: FPL, reached Full Performance Level. Devel., Developmental. Term. transfer, transferred to Terminal facility before reaching FPL status. FSS transfer, transferred to FSS facility before reaching FPL status. Fail, failed training and separated from ATC occupation.

Table 4–4: Terminal field training status by FAA Academy program

	FAA Academy Program[a]					
	Terminal Screen 1981-85		Non-radar Screen 1986-92		Group Total	
Field Training Status[b]	N	%	N	%	N	%
FPL	2,538	79.0	2,840	88.6	5,378	83.8
Developmental						
Facility switch	305	9.5	215	6.7	520	8.1
FSS transfer	68	2.1	14	0.4	82	1.3
Fail	301	9.4	136	4.2	437	6.8
Group Total	3,212	100.0	3,205	100.0	6,417	100.0

Note: [a]All percents are column percents.

[b]Terminal field training status: FPL, reached Full Performance Level. Facility switch, transferred to another Terminal facility before reaching FPL status. FSS transfer, transferred to FSS facility before reaching FPL status. Fail, failed training and separated from ATC occupation.

Table 4–5: En Route field training status by demographic variables

	En Route field training status[a]									
	FPL		Dev		Term Transfer		FSS Transfer		Fail	
	N	%	N	%	N	%	N	%	N	%
					Gender					
Male	5,292	71.4	34	.5	575	7.8	476	6.4	1,031	13.9
Female	871	72.5	14	1.2	107	8.9	63	5.2	147	12.2
					Minority Status[b]					
Amer. Indian	28	77.8			2	5.6	3	8.3	3	8.3
Asian-Pac.	60	84.5			3	4.2	1	1.4	7	9.9
African-Amer.	162	63.3	7	2.7	24	9.4	29	11.3	34	13.3
Hispanic	160	71.4	1	.4	17	7.6	8	3.6	38	17.0
Non-minority	5,630	71.6	40	.5	622	7.9	492	6.3	1,078	13.7
					Entry Type[c]					
Competitive	5,472	72.9	38	.5	557	7.4	473	6.3	971	12.9
Airway Science	31	79.5			3	7.7	1	2.6	4	10.3
Pre-Devel.	76	54.7	1	.7	22	15.8	11	7.9	29	20.9
Coop. Ed.	191	70.0	4	1.5	25	9.2	10	3.7	43	15.8
ATA	167	60.7	4	1.5	46	16.7	9	3.3	49	17.8
VRA	29	63.0	1	2.2	2	4.3	4	8.7	10	21.7
Noncompetitive	96	61.5			10	6.4	12	7.7	38	24.4
Former ATC	17	68.0			1	4.0	3	12.0	4	16.0
Former GS-9							1	100.0		
					Education[d]					
No coll. degree	3,752	74.0	31	.6	400	7.9	267	5.3	620	12.2
College degree	2,367	68.8	17	,5	274	8,0	238	6,9	542	15.8

Note: [a]Percents are row percents.

[b]Minority status: Amer. Indian, American Indian/Alaskan. Asian-Pac., Asian-Pacific Islander. [c]Entry: Airway Science, graduate of accredited Airway Science program. Pre-Devel., participated in FAA Pre-Developmental Program. Coop. Ed., Cooperative Education Program. ATA, former Air Traffic Assistant (GS-2154 or GS-2102.) VRA, hired under Veterans Readjustment Act. Former ATC, previously graduated from FAA Academy and failed field training. Former GS-9, previously hired under GS-9 military hire program and failed field training.

[d]Education: No coll. degree includes high school graduates and candidates with some college hours but no degree. College degree includes those with a bachelor's or higher degree.

Table 4–6: Terminal field training status by demographic variables

	Terminal field training status[a]							
	FPL		Facility switch		FSS transfer		Fail	
	N	%	N	%	N	%	N	%
Gender								
Male	4434	84.7	390	7.4	66	1.3	347	6.6
Female	944	80.0	130	11.0	16	1.4	90	7.6
Minority Status[b]								
Amer. Indian	33	84.6	2	5.1			4	10.3
Asian-Pac.	63	87.5	3	4.2	2	2.8	4	5.6
African-Amer.	197	77.0	22	8.6	4	1.6	33	12.9
Hispanic	132	80.0	21	12.7	1	.6	11	6.7
Non-Minority	4834	84.I	464	8.1	75	1.3	378	6.6
Entry Type[c]								
Competitive	4367	84.8	387	7.5	58	1.1	337	6.5
Airway Science	37	94.9	1	2.6			1	2.6
Pre-Devel.	119	72.1	19	11.5	6	3.6	21	12.7
Coop Ed	164	78.8	24	11.5	1	.5	19	9.1
ATA	309	79.4	48	12.3	4	1.0	28	7.2
VRA	42	89.4	3	6.4	1	2.1	1	2.1
Noncompetitive	182	75.5	28	11.6	5	2.1	26	10.8
Former ATC	83	89.2	4	4.3	4	4.3	2	2.2
Former GS-9	1	100.0						
Education[d]								
No coll. degree	3157	85.9	282	7.7	25	0.7	210	5.7
College degree	2042	81.3	229	9.1	26	1.0	214	8.5

Note: [a]Percents are row percents.

[b]Minority status: Amer. Indian, American Indian/Alaskan. Asian-Pac., Asian-Pacific Islander. [c]Entry: Airway Science, graduate of accredited Airway Science program. Pre-Devel., participated in FAA Pre-Developmental Program. Coop. Ed., Cooperative Education Program. ATA, former Air Traffic Assistant (GS-2154 or GS-2102.) VRA, hired under Veterans Readjustment Act. Former ATC, previously graduated from FAA Academy and failed field training. Former GS-9, previously hired under GS-9 military hire program and failed field training.

[d]Education: No coll. degree includes high school graduates and candidates with some college hours but no degree. College degree includes those with a bachelor's or higher degree.

Table 4–7: Time to attrition (years) by field option, FAA Academy program, and type of attrition

	FAA Academy Program					
	En Route or Terminal Screen 1981-85			Non-radar Screen 1986-92		
Type of attrition	*N*	*M*	*SD*	*N*	*M*	*SD*
			Terminal			
Switch FSS	68	1.65	1.98	14	1.65	0.62
Fail	300	1.06	1.05	136	1.22	0.63
Other	169	1.26	1.42	140	0.94	0.77
All types attrition	537	1.20	1.33	291	1.11	0.72
			En Route			
Switch Terminal	289	2.20	1.41	392	2.60	1.33
Switch FSS	423	1.08	0.98	115	1.84	1.00
Fail	726	1.17	0.93	449	1.75	1.02
Other	180	1.18	1.16	281	1.58	1.26
All types attrition	1618	1.33	1.15	1237	1.99	1.25

Note: Option: Switch FSS, changed options from either En Route or Terminal to Flight Service Station. Fail, failed training and separated from ATC occupation. Other, separated from ATC occupation for reasons unrelated to failure. Switch Terminal, changed options from En Route to Terminal.

CHAPTER 5:

ORGANIZATIONAL CLIMATE PERCEPTIONS OF THE AIR TRAFFIC CONTROL SPECIALIST (ATCS) WORKFORCE, 1981-1992

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Five organizational climate perceptions of Federal Aviation Administration (FAA) Air Traffic Control Specialists (ATCS) are examined from 1984 through 1990. These perceptions of job satisfaction, management concern for employees, management direction, pay and benefits equity, and organization of work were found in previous research to be related to the 1981 Professional Air Traffic Controllers Organization (PATCO) strike. Because of this relationship, FAA developed several human resources initiatives to enhance employee perceptions of these areas. Trend data for the five organizational climate dimensions are examined during the course of rebuilding the ATCS workforce. The results suggest the FAA made modest improvements between 1984 and 1988, but lost some ground in 1990.

On August 3, 1981, the Professional Air Traffic Controllers Organization (PATCO) engaged in a strike against the Federal Aviation Administration (FAA). The strike led to the termination of a large portion of the Air Traffic Control Specialist (ATCS) workforce. The strike also led to an examination of the organizational climate perceptions of the FAA's ATCS workforce (Jones, Bowers, & Fuller, 1984). Climate perceptions of the agency's employees have been obtained biennially since that initial assessment as part of the agency's human resource initiatives developed in the wake of the strike. The purpose of this paper is to describe controller perceptions of organizational climate during the rebuilding of the ATCS workforce.

The FAA and PATCO had a difficult relationship for a number of years. The strike was the culmination of this conflict. On the day of the strike, more than 10,000 controllers walked off the job. President Reagan gave the strikers 48 hours to return to work, which served as a cooling off period and a deadline. The FAA implemented a strike contingency plan with non-striking employees, military controllers, and supervisors filling in for the strikers. In the end, those controllers who did not return to work were terminated and the union was decertified. The FAA had to quickly replace a substantial portion of its workforce, find out why the strike occurred, and if possible, correct the problems.

One of the investigations conducted by the FAA focused on employee-management conflict, and included an assessment of employee perceptions. The assessment resulted in the "Jones Report" (Jones, Bowers, & Fuller, 1982). Jones et al. identified several correlates of the strike, such as increasing utilization of the National Airspace System (NAS), episodic controller stress, equipment failures, poor management/employee relations and communication, and, in general, low morale. The Jones Report found that morale in the FAA was very low, even at the upper levels of the agency's hierarchy. Morale was indicated by the summary pattern of employee perceptions about the agency. Areas of particular concern included satisfaction, management concern for employees, rewards (pay and benefits), organization of work, and managerial and supervisory direction.

For the FAA as a whole, the Jones Report results indicated a low level of job satisfaction. Job satisfaction is typically treated as an outcome of the management of human resources, so low job satisfaction scores are often interpreted as problems with management (Cranny, Smith, & Stone, 1992). Similarly, the employees perceived that management did not consider the effects of decisions on employees, suggesting that management did not obtain adequate employee input. Employees also perceived the job to be inadequate in terms of formal and informal rewards. Instead, the perception was that rewards were

based on annual performance reviews that may or may not have been related to actual day-to-day performance. The organization of work, in terms of the procedures and processes involved in completing assigned duties, was perceived to be problematic by controllers. Finally, managerial and supervisory direction was rated poorly by the ATCS workforce. Problems with supervisors were believed to be primarily due to the autocratic style of supervisors selected from the ranks of controllers.

The perceptions of striking and non-striking controllers were compared in the Jones Report. The results indicated that controllers who struck, and were subsequently fired, and controllers who remained had a similar pattern of organizational perceptions, although the striking controllers generally indicated lower levels of most perceptions. In addition, the data indicated that the strike occurred, in part, due to "...an organization climate that they [ATCSs] experienced as uncaring, unconcerned for its people, uncommunicative, and unreceptive" (Bowers, 1983, p. 16). In response to these conclusions the FAA developed several national human resource initiatives that targeted the morale and supervision problems identified in the Jones Report. These initiatives included survey-feedback programs to respond to employee concerns, improvement of the selection and human resources training of supervisors, and changing pay systems.

One of the primary FAA responses to the strike was the implementation of an agency-wide biennial employee survey. The biennial survey was created to provide management with a picture of employee perceptions, and to provide a means of tracking those perceptions over time. In addition, feedback from the survey provided management with information regarding problem areas to be addressed. Following the first administration of the survey in 1984, interviews were conducted in three regions to further clarify why people responded they way they did. The interviews indicated the areas of primary concern were related to human resource management practices. In addition, regions were expected to formulate action plans to address human resource management problems within the region. The regional plans were then combined into a national plan (Weithoner, 1985). Human resources specialists were hired in each region to further support efforts to initiate plans and programs to address these issues.

After the 1986 administration of the agency-wide employee survey, the feedback and action planning process that had emerged from an earlier administration was augmented and formalized in the Survey Feedback Action (SFA) program. The SFA relied on two surveys: (1) The biennial national survey described above that focused on national, agency wide issues, and (2) regional surveys focused on more specific regional issues. The regional surveys assessed employee perceptions of supervisors and management. Based on the results of the regional surveys, regional plans were developed to improve training, communication, and supervision. The effectiveness or impact of these regional action plans were to be evaluated with the next round of surveys.

Another problem for the agency that resulted from the strike was under-staffing of ATCSs. Understaffing was an immediate problem following the strike because it takes as long as 3 years after hiring to train a controller to Full Performance Level (FPL; VanDeventer, Collins, Manning, Taylor, & Baxter, 1984). Understaffing of ATCSs was a continuing problem for the FAA in some facilities (General Accounting Office, 1986, 1989). To enhance recruitment and retention of employees, the DOT/FAA Pay Demonstration Project (U. S. Office of Personnel Management, 1989) was implemented. This project provided retention bonuses to employees in safety-related occupations such as ATCS, electronics maintenance technicians, and aviation safety inspectors at difficult to staff facilities.

Another change that occurred due to the strike was the influx of a large number of new employees. After the termination of the striking controllers, replacements had to be hired, trained, and placed on the boards. These new hires differed from the replaced controllers in terms of previous experience and aptitude (VanDeventer, Collins, Manning, Taylor, & Baxter, 1984). In addition, there were some differences in the training of pre-and post-strike controllers. In order to rapidly replace the controllers, the agency hired a substantial number of replacements "off the streets" who were required to complete the FAA Academy screen, followed by continued training at the FAA Academy and in the field. A smaller number of former military controllers were hired at higher grade levels and placed directly into field facilities for on-the-job training (Manning, Kegg, & Collins, 1989; Manning & Aul, 1992). The new

hires, however, were placed into the same organizational climate that had created the circumstances that led to the original strike.

A final program, the Supervisor Identification and Development Program (SIDP; Myers, 1992), was created to address inadequate supervisor/subordinate communication. The SIDP was created initially for the air traffic, electronics technician, and aviation safety inspector workforces. The purposes of SIDP were to enhance the quality of supervisors selected for internal advancement from the workforce, and to provide improved training in human relations supervisory skills. At the same time, the FAA's Center for Management Development changed its courses to support this effort. Again, the Jones report had indicated that one of the FAA's problems was the way that management, and to a lesser extent, first and second line supervisors, treated subordinates. SIDP consisted of a self-selection of candidates, who were then rated by peers and supervisors on four performance dimensions: interpersonal, communications, direction and motivation, and technical competence. Candidates were then given a skill-based interview. From there, candidates were considered to be eligible for promotion consideration, given further review, or asked to enhance their leadership skills and reapply (Myers, 1992).

Given the continuing efforts of the FAA to improve the organizational climate, and the influx of new organization members following the strike, it seems prudent to assess any changes in the perceptions of agency employees, and in particular, the perceptions of air traffic controller specialists (ATCS). The four national initiatives, the biennial survey, SFA, the Pay Demonstration Project, and SIDP, coupled with the influx of new employees, may have improved the organizational climate of the FAA. Indeed, the four national human resource initiatives were developed specifically to enhance the FAA's organizational climate. The human resource initiatives undertaken during the recovery of the ATCS workforce have their roots in the conclusions drawn by the Jones Report. The extent to which these projects had an effect on employee perceptions will be examined next.

Method

Participants and procedures

Biennial surveys of varying content were administered to FAA employees on four occasions (1984, 1986, 1988, and 1990). The first two administrations consisted of a census of all agency employees. The latter two administrations consisted of a stratified random sample of approximately 15% of the agency. This sample consisting of air traffic controllers (Tower, En route, or Flight Service Station personnel) and supervisors was drawn from the larger samples of the FAA. The ATCS samples for each administration were: 12,478; 14,222; 2,106; and 2,485, respectively.

Measures

Five organizational climate dimensions assessing content areas similar to those identified as problem areas by Jones et al. (1982) were examined. Each dimension was assessed with the same items for each survey administration, except for job satisfaction and equity of pay and benefits. The initial survey included a single item measuring job satisfaction. This single item job satisfaction measure has been used as a benchmark of job satisfaction since 1984. The three subsequent surveys included additional satisfaction measures (satisfaction with pay, benefits, physical working conditions, work group, supervisor, and organization) that were averaged to form a satisfaction index (average $\alpha = .77$). The single job satisfaction item and the satisfaction index provide two measures of overall morale in the agency. Such satisfaction measures are commonly used as outcome measures in studies of organization change (Cranny, Smith, & Stone, 1992). The second measure focuses on perceptions of management's concern for employees, which was assessed with 3 items (average $\alpha = .89$) from Jones et al. (1982). Management consideration examines the extent to which management takes into account the effects of decisions on employees. Employee perceptions of pay and benefit equity (formal rewards) were initially assessed with two items (e.g., pay and job security equity) in 1984. Two additional items (e.g., retirement and benefits equity, average $\alpha = .74$) were incorporated in subsequent surveys. Perceptions regarding the way work was organized were

assessed by 4 items (average $\alpha = .87$). The amount of direction provided by management was assessed by 3 items (average $\alpha = .87$). Management direction includes things such as setting of goals, and providing the employees with appropriate guidance. For all of the multiple-item measures, the items assessing the dimension were averaged to obtain a single dimension score.

Results

A one-way ANOVA demonstrated there was a significant trend in the reporting of the job satisfaction item, $F(3, 31164) = 68.70, p \leq .001$. The means and standard deviations for each survey administration are presented in Table 5-1. As can be seen, there was a gradual increase in job satisfaction between 1984 and 1988, and a slight decrement in 1990. However, levels of job satisfaction in 1990 were still above those noted in 1984 and 1986. Post hoc analyses indicate all means are significantly different. Because of the very large number of respondents, however, any difference between means is likely to be statistically significant. Therefore, the effect size, or the amount of variance accounted for was examined (Cohen, 1988, 1992). For this analysis, the amount of variance accounted for was very small ($\eta^2 < .004$). The small effect size is due, in part, to the single item measure of job satisfaction, which has a larger standard deviation compared to measures based on multiple items, as can be seen in Table 5-1.

To determine if there were any differences in the reported perceptions of the five multiple item measures of organization climate across administrations a one-way MANOVA was conducted. This test indicated the presence of at least one significant difference, $F(15,93024)=151.02$, $p \leq .001$. Follow-up univariate analyses for each of the five dependent variable measures were also statistically significant. The descriptive statistics for this analysis are also reported in Table 5-1. Again, however, because of the number of respondents, effect sizes were examined for each analysis (Cohen, 1988, 1992). With a single exception, the effect size of each analysis was trivial (e.g., $\eta^2 < .01$). The exception was for pay and benefits satisfaction ($\eta^2 < .042$). While this is still a small effect, an examination of the means indicates that the level of perceived equity of pay and benefits decreased most after the first assessment.

The lack of discernible upward or downward trends in the above analysis led to an examination of response rates. For this analysis, the individual responses to each item that comprise a measure were assessed to determine what proportion of responses can be categorized into disagree, neither agree nor disagree, or agree for each administration of the survey. Figure 5-1 shows the trend for the single item measure of job satisfaction. As can be seen, there is a noticeable upward trend from 1984 to 1988, with a drop in 1990. Figure 5-2 shows there is a bimodal distribution of responses to the job satisfaction index with just over 50% of the respondents indicating satisfaction, and about one third indicating dissatisfaction. In 1986, 1988, and 1990 the discrepancy between the job satisfaction item and the satisfaction index is primarily due to lower ratings of benefits satisfaction, and to a lesser extent, to items dealing with working conditions and organization satisfaction.

The percent of respondents indicating management has a concern for employees also increases slightly across the first three survey administrations (see Figure 5-3). At the same time, the number of respondents disagreeing decreases. A different pattern of responses emerges for pay and benefits, and is summarized in Figure 5-4. Here, a majority of respondents indicate that pay and benefits are equitable, while 20% disagree. There is no upward trend for the first three administrations. Again, it appears that perceptions regarding benefits reduce the number of respondents perceiving equity. Perceptions of benefits on the 1986 survey may be related to the process of conversion from the Civil Service Retirement System (CSRS) to the Federal Employee Retirement System (FERS). Figure 5-5 shows the response rates for the degree to which ATCSs indicate work is well organized. There is an upward trend in the agree category from 1984 to 1988, followed by a drop. Finally, Figure 5-6 also shows an upward trend for the respondents who report adequate management direction, and a corresponding downward trend for respondents who disagree. Once again, in 1990, the percent of agree respondents drops. Overall, there appears to be an improvement in perceptions of ATCSs from 1984 to 1988, as reflected by increased agreement and decreased disagreement for most of the climate dimensions. It is likely that the 1990 drop in perceptions for many of the climate dimensions is

related to the short-term budgetary furloughs the agency underwent immediately prior to the distribution of the survey.

Discussion

This study briefly summarizes the perceptions of five organizational climate dimensions identified as problematic by Jones et al., and related to the PATCO strike in 1981, and examines the FAA's interventions on controller perceptions over the course of the ATCS workforce recovery. At a national level, the FAA tried to improve the selection and training of supervisors, to enhance communication and understanding through the use of survey feedback, and tried to create more rewarding jobs by altering pay systems. The results suggest that these interventions have had a small positive impact, but have not markedly altered the perceptions of ATCSs between 1984 and 1990. Relevant perceptions did improve slightly from 1984 to 1988, then decreased slightly in 1990.

Of course, the apparent lack of change must be viewed with some caution because of methodological flaws with the present study. The methodological problems include issues of measurement and design. One methodological caveat is the use of self-report measures. The exclusive reliance upon self-report measures can create a susceptibility to monomethod bias. Such a possibility is minimized, however, due to the measures being obtained at different times. A second methodological problem is an inability to match respondents from one administration to the next. Unmatched respondents create pseudo-independent raters for each administration, and thus it is only possible to examine agency trends, and not change per se. Moreover, such analyses create more conservative tests, because individual response biases cannot be taken into account. In addition, the lack of a control group is a design flaw, leaving open the possibility that unknown external factors influenced employee perceptions, either positively or negatively, in addition to the human resource initiatives (e.g., changing retirement systems and furloughs).

Although methodological problems exist for the present study, there are also several possible substantive explanations for why ATCS perceptions have not changed substantially. It is possible that the interventions were not adequately developed, implemented, communicated, or that the interventions targeted inappropriate organizational dimensions or groups. For example, the feedback from surveys was primarily directed towards management, with management then developing action plans based on the data. Employees generally received only feedback summaries, and the degree of employee involvement in action planning varied regionally. Similarly, the pay demonstration project was not generalized to the entire workforce. Also, SIDP was eventually stopped because ratings of peers were being conducted quid pro quo, making the rating an ineffective predictor of supervisory skills. Another possible explanation is that the survey methodology used to assess changes was insensitive to the perceptual changes that did occur.

Over the course of rebuilding the ATCS workforce, the influx of new controllers and the human resources initiatives lead to small improvements in the perceived organizational climate. Small changes, as opposed to massive shifts, and some setbacks, are to be expected because substantially changing an organization, especially a large organization, is difficult and time consuming. Because changes take place over time continuous and repeated efforts are needed. Of course, efforts to improve the FAA and the work environment of ATCSs continue (e.g., FAA, 1996; General Accounting Office, 1996). Specifically, recent changes in personnel and acquisition reform are expected to aid in the selection of new employees and ease the purchase and placement of new technologies, both of which should contribute to enhanced climate perceptions of the ATCS workforce.

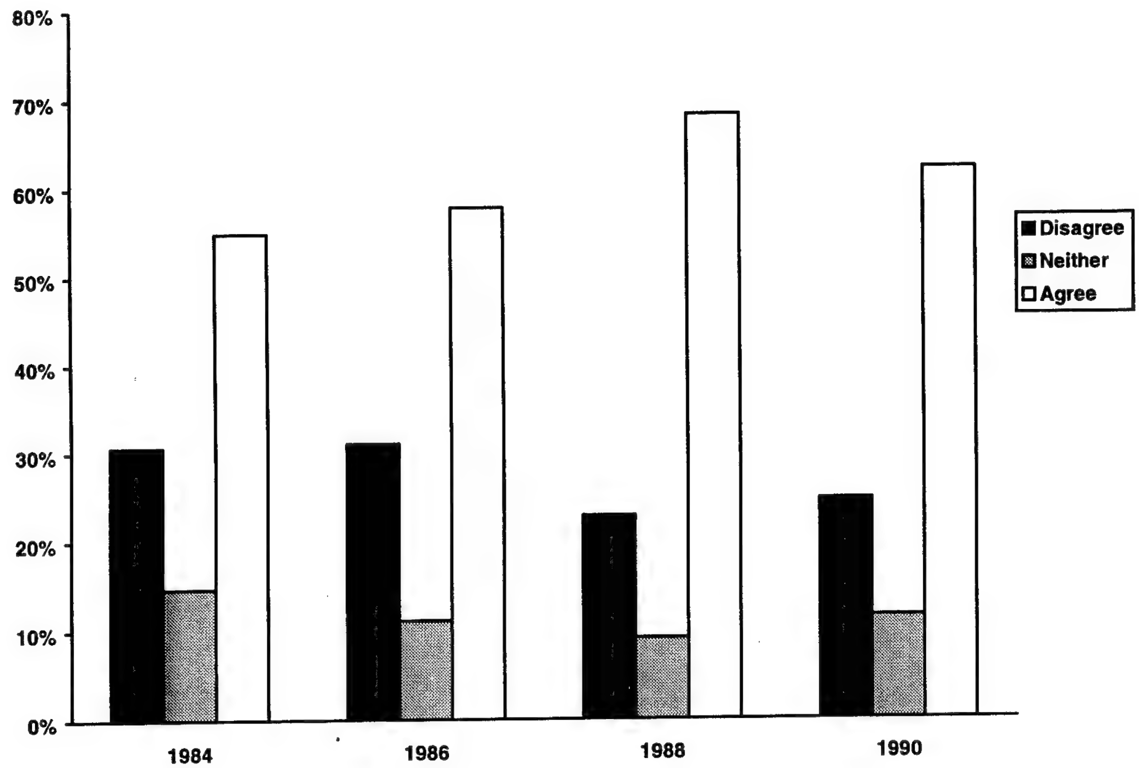

Figure 5–1: Job satisfaction (based on a single item) perceptions of air traffic control specialists

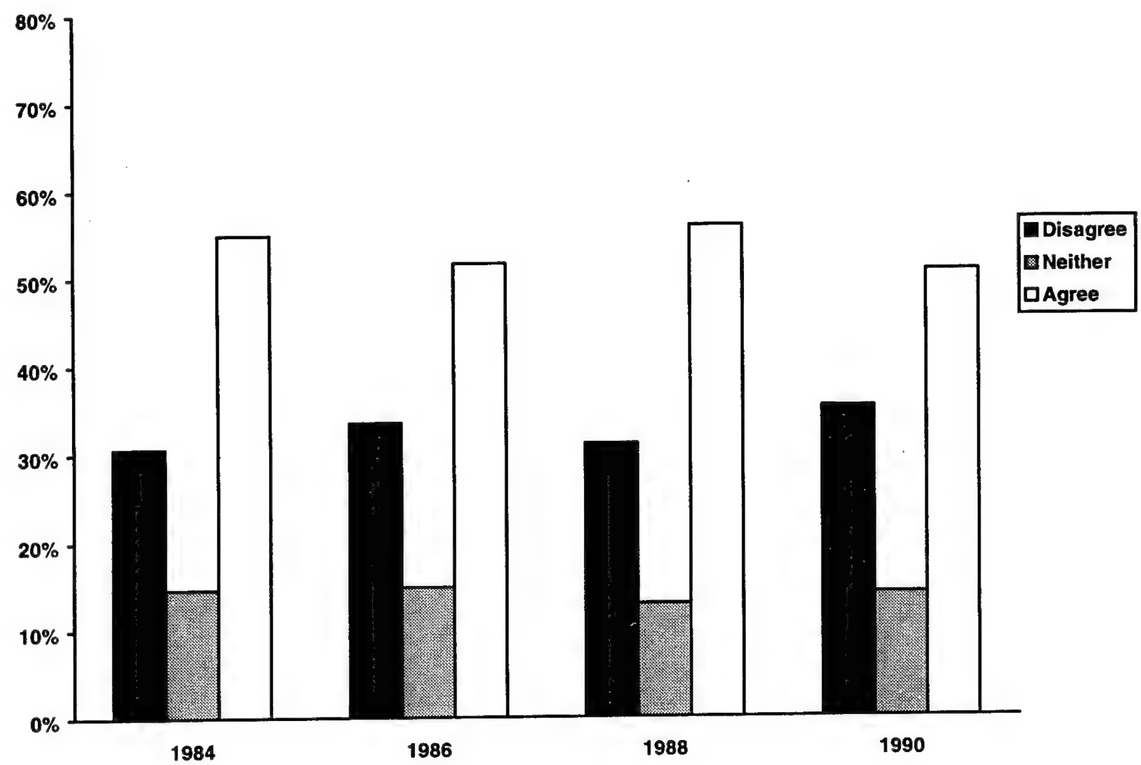

Figure 5–2: Satisfaction perceptions of air traffic control specialists

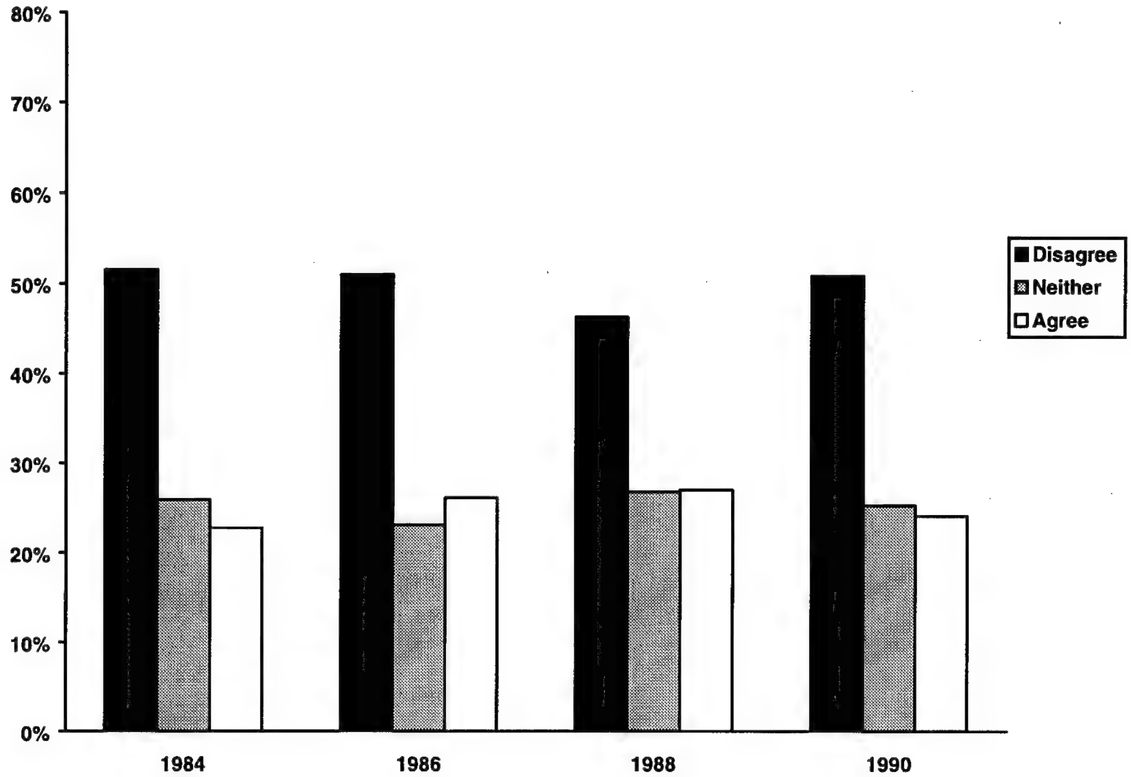

Figure 5–3: Management concern for employee's perceptions of air traffic control specialists

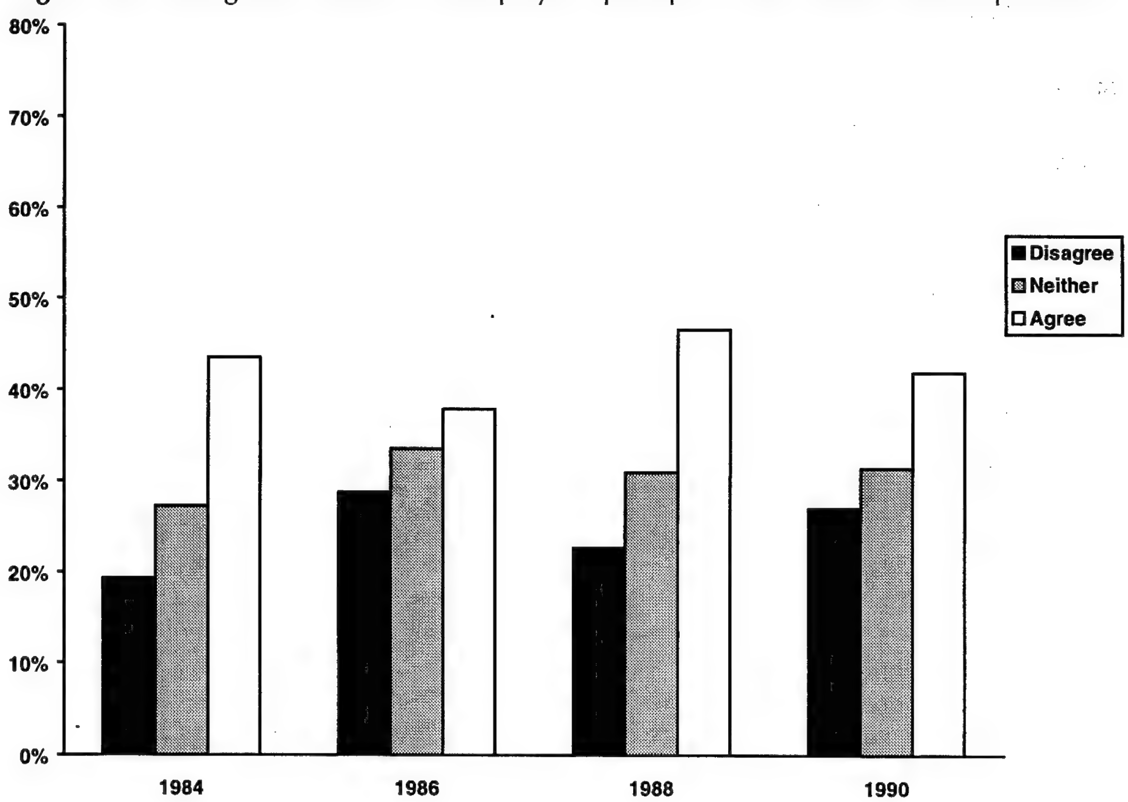

Figure 5–4: Pay and benefits perceptions of air traffic control specialists

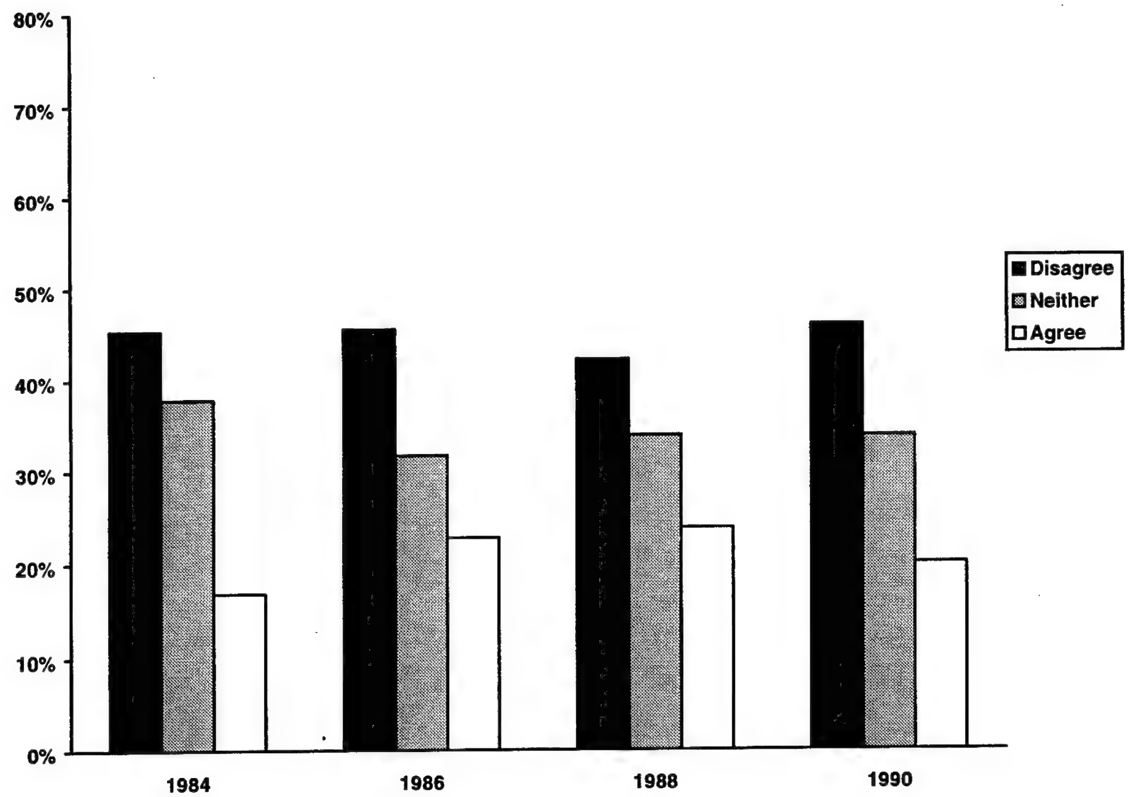

Figure 5–5: Organization of work perceptions of air traffic control specialists

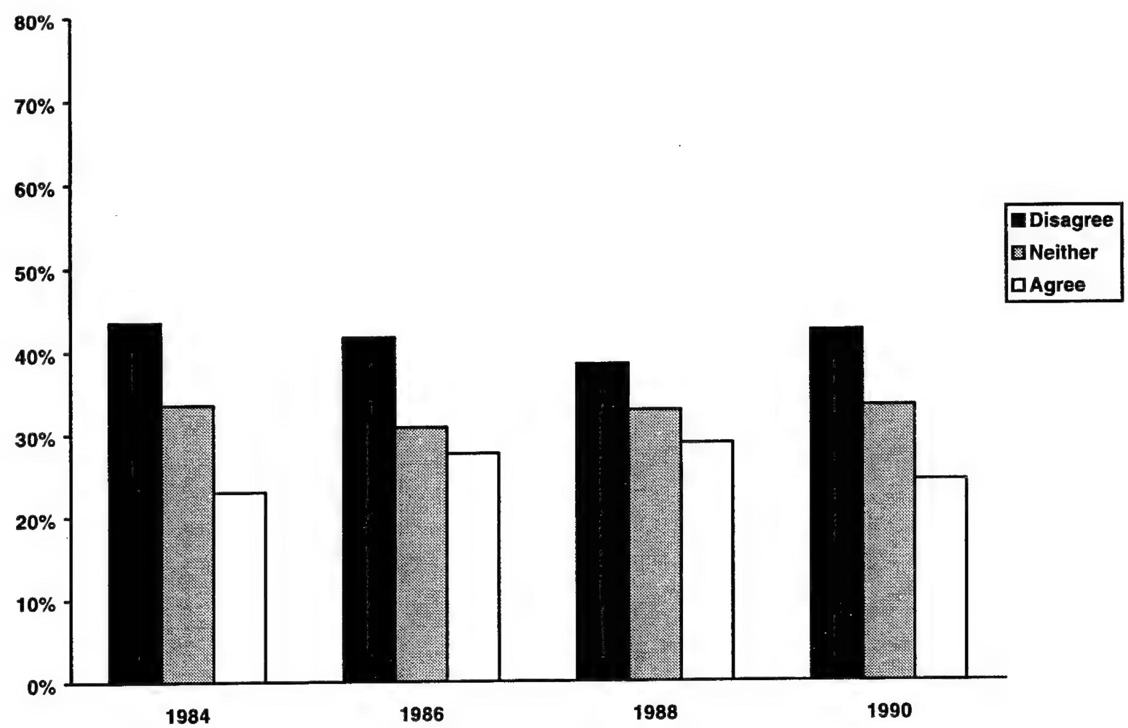

Figure 5–6: Management direction perceptions of air traffic control specialists

Table 5–1: Sample Size, Means and Standard Deviations for the Organization Climate Measures by Survey Administration

	1984 (*N* =12,377)		1986 (*N* =14,027)		1988 (*N* =2,086)		1990 (*N* =2,456)	
Organization Climate Measures	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Job Satisfaction[a]	3.32	1.25	3.37	1.23	3.64	1.15	3.49	1.18
Satisfaction	3.32	1.25	3.26	0.80	3.35	0.78	3.22	0.78
Management Concern for Employees	2.31	0.99	2.49	1.04	2.57	0.98	2.42	0.96
Pay and Benefits	3.49	0.89	3.12	0.76	3.32	0.71	3.20	0.75
Organization of Work	2.53	0.85	2.69	0.91	2.75	0.85	2.65	0.85
Management Direction	2.92	0.83	2.98	0.87	3.04	0.84	2.92	0.85

Notes: [a]Based on a single item

CHAPTER 6:

CURRENT FAA CONTROLLER WORKFORCE DEMOGRAPHICS, FUTURE REQUIREMENTS, AND RESEARCH QUESTIONS

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Between 1981 and 1992, the Federal Aviation Administration replaced approximately 11,500 air traffic controllers in the wake of the 1981 Professional Air Traffic Controller Organization (PATCO) strike. Three issues are considered in this paper: the aging controller workforce after the year 2000, training for advanced air traffic control technologies with an aging workforce, and recruitment and selection criteria for future controllers. Ongoing research to address these issues are described.

Following the Professional Air Traffic Controller Organization (PATCO) strike of 1981, the Federal Aviation Administration (FAA) was tasked with replacing approximately 10,400 air traffic controllers. As the point of retirement eligibility for the first of these replacement controllers approaches, a considerable amount of resources will need to be invested in planning for and initiating recruitment, selection, and training programs for the inevitable influx of new controllers. As a result, the FAA faces a number of personnel-related research and operational questions. This paper focuses on three issues:

- Aging of the Air Traffic Control Specialist (ATCS) workforce;
- Employee training for the advanced National Airspace System (NAS) air traffic control (ATC) system technologies; and
- The recruitment and selection of personnel to operate the more automated ATC system of the future.

Earlier papers in this volume focused on the processes and tools used to rebuild the controller workforce after the 1981 strike. But as the present workforce ages, and inexorably moves toward retirement eligibility, the issue of future selection to replenish the ATC system becomes critical. Combined with this are the soon to be changing demands imposed by the evolving NAS (FAA, 1996). A large amount of research has gone into defining the knowledge, skills, and abilities of the ideal air traffic controller. As system dynamics and technologies change, many of those essentials that define performance in today's system may no longer be as important in tomorrow's job. With this in mind, current efforts are focused on defining the new system and the skill requirements of the future controller workforce.

Aging of the ATCS Workforce

The vast majority (87.9%) of the current ATCS workforce entered the FAA following the PATCO strike of 1981. To better understand the characteristics of the ATC population, we extracted information regarding its age and experience distributions from the Consolidated Personnel Management Information System (CPMIS) maintained by the FAA (Figure 6-1). The sample of 14,569 ATCSs (as of April 1996) does not include personnel who were listed in ATCS office, staff, or supervisory/management positions. Since a significant portion of the workforce was hired in the decade following the ATC strike of 1981, we found the expected bulge of controllers (62.7%) in the 30-39 age range. The average age of the current workforce is 37, with a standard deviation of 6.38 years. Of this sample of 14,569 active controllers, 11.3% of the controllers were 40 years of age and older, and they had at least 15 years' experience. The percentage of the post-strike group that will fall in that same category in 2001 increases to 40%. By 2011, nearly the entire population of the current workforce will either be in that group, or will have already retired.

Projections of the staffing requirements and associated air traffic levels are presented in Figure 6-2. A gradual increase in ATCS staffing over the next two decades is designed, in part, to keep pace with the expected increase in aviation activity (Air Traffic Services, 1996). To determine the effects of the continued aging of the current group of controllers on the need to hire and train new personnel, we developed a research model that allows us to forecast the number of ATCSs eligible for retirement over the next decade. Recognizing that there are many factors that can be incorporated into a model for projecting the hiring and training flow of the future, ours is sensitive both to attrition associated with deaths due to accidents and other health conditions (this is not age corrected so it represents a conservative estimate of losses attributed to these events) and the availability of retirement eligibility at age 56. While different models may produce slightly different predictions, the general shape of the distributions remain relatively the same. Using this research model, we projected the number of retirement-eligible controllers from 2001 through 2020, as illustrated in Figure 6-3. The greatest potential loss due to retirements of ATCSs will occur around 2015 to 2017. By 2016, over 50% of today's ATC workforce will have reached the age at which they are eligible for retirement.

The General Accounting Office (GAO) was critical in a recent report (GAO, 1997) of the FAA's retirement projections that were based on the assumption that, in any year, around 20% of those eligible would retire. The GAO developed projections that were based on recent data that indicated that the average controller retires at 56 years of age with 31 years of service. When compared with the FAA projections, GAO predicted smaller numbers of retirees in 1997 through 2001. GAO based their calculations on the probabilities of retirement of controllers in various age cohorts during fiscal years 1992-1996. The average yearly retirements would increase from 198 in 1997 to 299 in 2003. In 2009, more than 600 retirements would be expected. That average number of yearly retirements is likely to remain at that level or higher for several years, given the large numbers of ATCSs who will reach age 56 from year 2009 through 2017.

Controller Aging and Performance

Another consideration associated with the overall aging of the workforce during the first two decades of the 21st century concerns the potential effects of aging on cognitive functioning and the consequences of those changes for on-the-job performance. There are indications in the scientific literature that during the middle decades of life most individuals experience some decline in the speed of their cognitive functioning. In fact, Fozard and Nutall (1971), in their study of age-related changes in scores on the General Aptitude Test Battery (GATB), indicated that the average 60 year-old individual would be able to meet the occupational aptitude patterns for only 17 of 36 occupations. Changes are more frequently observed in the fluid or process aspects of cognition (speed of processing information, memory, and making decisions). Some scientists feel that overall performance on those tasks may start to decline at ages as early as in the 20s (Salthouse, 1990). However, what is often referred to as the crystallized measures of intelligence (vocabulary and general information) may improve with increasing age until the late 60s. When viewed in the context of most jobs, Schaie (1988) has argued that the reported age differences are generally too small to have meaningful consequences. However, little has been said about the potential implications of these changes for personnel in safety-related positions where speed of information processing, memory, and decision-making are of critical importance.

Nearly all of the scientific information available refers to the effects of age-related declines in performance on somewhat novel laboratory tasks, compared with more familiar tasks or job performance. A series of studies by Trites, Cobb, and their associates (e.g., Cobb, Lay, & Bourdet, 1971; Trites, 1963; Trites & Cobb, 1964a; 1964b) consistently demonstrated an inverse relationship between age of entry and performance of ATCS trainees at the FAA Academy and in field training. Those studies led to Congressional action to restrict the age of entry into the FAA Academy training to age 30.

A subsequent Civil Aeromedical Institute (CAMI) study (VanDeventer & Baxter, 1984) of 8,573 FAA Academy trainees where the age of entry was more

restrictive (18-30) than that studied by Cobb and associates, demonstrated the typical inverse relationship between age and pass rate. Figure 6-4 presents the outcomes in the FAA Academy screening programs for 27,925 entrants from 1981 through 1992. Overall success in the FAA Academy declined from 66.6% of those age 22 and younger to 53.7% of those aged 27-28, and 48.6% of those in the 31 or older age category. Age-related changes were evident in both the failure rates as well as withdrawals. Lowered success rates were also evident in field training. Outcomes for the FAA Academy graduates initially assigned to an en route ATC facility for training are presented in Figure 6-5. To be consistent with Manning's (this volume) analysis of OJT outcomes, controllers still in training, or who left training for reasons other than performance, were excluded from this analysis. While 80.7% of those age 22 or younger successfully reached the full performance level at their first en route facility, only 52.8% of those in the oldest age group (31+) did. From the younger through older age groups, there was a systematic increase in the percentages of trainees who switched to another option (Terminal or Flight Service Station) or were terminated from training.

The overall success rates of trainees entering the terminal option were considerably higher, ranging from 88% for those aged 22 or younger to 78.6% of those aged 31 and older. One indication of the lower overall difficulty of the terminal option on-the-job training program is the time required to reach full performance level (FPL) status. It ranges from slightly over one year at the level 1-2 terminals to approximately 2 1/2 years at a level 4 or 5 facility. The latter is still below the average of slightly more than three years required at the en route centers. Much of the observed difference in success rates across ages can be attributed to outcomes from the larger terminal facilities (Level 4 and 5). Percentages of post-strike trainees who completed, switched options, or washed out of field training at the level 4 and 5 terminal facilities are presented in Figure 6-6, again excluding those still in training or who left for reasons unrelated to job performance. The percentage who reached FPL status ranged from 76.9% of controllers in the 22 years of age or younger group to 46.3% of those in the 31 and older age group. Thus, in the more demanding terminal environments, there is evidence of the expected age-related decline in on-the-job training success. Most of the trainees at level 5 terminal facilities are selected from the ranks of FPL controllers at other facilities. These outcomes are again consistent with historical data gathered from respective field facilities (Trites, 1963; Trites & Cobb, 1964a, 1964b). Thus, older adults experience greater difficulty completing the FAA Academy screening and on-the-job training programs for Air Traffic Control Specialists.

Some scientists have argued that we are not likely to observe age-related differences at work because many of the tasks are in continuous use and are thus highly over-learned. It is difficult to assess the extent to which older employees may be less proficient at work due to the multitude of factors that influence attrition as employees age (poorer workers often drop out or move to other jobs, and the best are often selected for promotions or are given opportunities to switch to more challenging jobs). The effects of seniority on job assignments in many occupational settings are also often poorly understood. Salthouse (1990) describes several mechanisms that may serve to preserve overall competency and job performance as adults experience age-related declines in the efficiency of basic processes: compensation, accommodation, elimination, and compilation. Rhodes (1983), in a review of age-related differences in work attitudes and behavior, concluded that the outcomes from studies of the relationship between age and job performance are mixed. Older employees did express higher levels of job satisfaction, satisfaction with the work itself, and job involvement.

Evidence for a possible moderating effect of experience on the typical effects of age on job-related tasks is mixed. General support was found by Salthouse for typing tasks (1990) and by Morrow, Leirer, Altieri, and Fitzsimmons (1994) on readback of visual or vocally-presented ATC communications. Evidence was more limited for a set of time-sharing tasks involving groups of pilots and non-pilots (Tsang & Voss, 1996). Salthouse, Babcock, Skovronek, Mitchell, & Palmon (1990) found little support among groups of practicing architects on spatial visualization tasks. Thus, while there is some laboratory-based evidence to support the critical role of expertise or experience in the performance of older workers on job-related tasks, there is insufficient job-related performance research available to clearly document the importance of various factors in determining

the job performance of older workers, particularly in safety critical occupations. However, Cobb and associates (Cobb, 1967; Cobb, Nelson, & Matthews, 1973) have demonstrated that combined ratings (supervisors, crew chiefs, and coworkers) of controller performance are lower for older than for younger controllers. This is consistent with data gathered earlier at the en route centers. There are several factors (motivation, differences in aptitudes and abilities, and rating bias) that may have contributed to these differences, other than physiological aging. While we do not understand the full implications of the age-related changes on the performance of air traffic controllers, careful attention should be paid to what appears to be age-related performance changes as the overall age of the controller workforce increases during the next 15 years.

Training Implications

Based on the projected increase in retirement eligible personnel and the lead-time of around two to three years for individuals to complete training, the FAA is in the process of developing plans to hire controllers over the next two decades. Facilities will thus have expanding training requirements over the next 20+ years to equip new controllers to handle traffic in the future, as older controllers retire. However, this is not the only training burden faced by facility managers and the Air Traffic Service. Within the next 20 years, enhanced hardware/software ATC work stations, decision aids, and new policies and procedures will be introduced into the NAS to improve capacity and to increase safety and efficiency. By the turn of the century we will observe the effects of the introduction of data link, the ARTCC Display System Replacement (DSR), Standard Tower Automation Replacement System (STARS), Global Navigation Satellite System (GNSS) technologies, and airborne warning technologies. During the first decade of the 21st century, new decision support systems will be introduced. Emphasis on integrating "free flight" concepts into the NAS may result in a number of significant changes in how air traffic is handled. Under some proposals there may be a shift in responsibility for separation of aircraft between flight crew members and controllers, as a part of "free flight." No matter which scenario is finally adopted, the introduction of these new systems and procedures into the NAS over the next two decades will generate continuing requirements to train ATCSs to operate these new systems. Since these changes will largely coincide with the influx of new controllers, it will present a significant logistical effort with respect to retraining the existing cadre of full performance level controllers, while training new controllers at the same time. Concerns about the availability of sufficient staff within the facility to maintain normal operations and still provide on-the-job training are likely to be of special concern at facilities that have been identified as "hard-to-staff," where staffing levels have remained below projected levels. Thus, there will be a general need for facility-specific plans to address the training requirements associated with the hiring of new controllers to replace retirees and the retraining of the existing workforce to function on the more automated systems of the future.

While the cognitive changes in performance capabilities may not pose a significant problem for the safe and expeditious flow of traffic under typical conditions, it may pose additional burdens as older ATCSs are required to transition to new technologies and new procedures. Evidence suggests that older employees experience greater difficulty acquiring new skills than do younger employees (Charness & Bosman, 1990). In the use of computer technology, there is research that suggests that older adults require longer training time and, in general, do not obtain the same level of skill as younger individuals (Czaja, 1996; Sharit & Czaja, 1994). The difficulty of this transition is, of course, dependent on the extent to which the job changes and the nature of those changes. At this point, we do not know enough about the proposed future systems to determine the extent to which age-related factors should be considered in the development of the new procedures and training programs. Human factors assessments will be needed to determine the appropriateness of training approaches for transitioning to the new technologies.

Selecting Controllers for Future Systems

Presentations made earlier in this session have illustrated efforts associated with the recruitment, selection, and training of new ATCSs. Research is currently ongoing with respect to developing and validating a 3rd generation computer-administered test battery to select controllers for the near term (1998 - 2005). But what are the cognitive and personal characteristics that may be needed by controllers operating future systems? The new technologies will involve greater automation and the availability

of increased decision aiding. The extent to which the new system and procedures impact on the nature of the job is highly dependent on the level of automation selected (Wickens, Mavor, & McGee, 1997). In his recent book on automation in aviation, Billings (1997) provides four scenarios regarding the nature of the future air traffic control system: management by delegation; management by consent; management by exception; and free flight. There are marked differences in the roles and responsibilities of ATCSs under these scenarios. Both the Automated En Route air traffic control (AERA) and free flight concepts appear to raise a number of human factors concerns related to controller-machine interactions.

CAMI scientists have embarked on a program of research designed to provide an answer to those questions. The initial study was designed to assess controller perceptions of AERA and determine how perceptions of task activities under AERA would impact the requisite knowledge, skills, and abilities of ATCSs. Findings by Manning & Broach (1993) indicate that many of the same skills and abilities might be required. Since we are no longer moving down an identical technological pathway, the question remains regarding the demands and job tasks associated with the future ATC systems. The infrastructure technologies that are being readied for introduction into the NAS during the remainder of this decade are not likely to dramatically alter the job duties and functions of ATCSs. However, the implementation of the initial and upgraded versions of decision-support systems, and the revised AERA system are likely to substantially modify the nature of the job. Given the time required to recruit, select, and train personnel, a new advanced selection system needs to be developed coincident with the development of the proposed future systems.

Traditional approaches to job analysis have focused on jobs that incumbents have already been performing. In planning for the future, an approach is needed that will allow us to identify the knowledge, skills and abilities required as the systems are under development. One strategy is to utilize the "strategic job analysis" approach presented by Schneider and Konz (1989). Efforts are underway at CAMI to develop the methodology required to conduct a strategic job analysis for both air traffic control and airway facilities positions. Once developed, the approach will be used to assess the changes in knowledge, skills, and abilities as new systems are developed for the NAS. With the anticipated increased emphasis on coordination and shared decision-making, there may be additional requirements to identify personality dimensions that play a critical role in teamwork. Of course if the level of automation selected is one where the human operator is primarily a system monitor and will only take over in the advent of an automation-related failure, this presents a much different view of the nature of the job and the necessary knowledge, skills and abilities. Outcomes from the future job analysis assessments will be compared with the recent baseline job analysis data (Nickels, Bobko, Blair, Sands, & Tartak, 1995). The identification of the requisite knowledge, skills, and abilities that are sufficiently different from those required with current systems will be used to modify existing selection and training programs. Ideally, this will allow the FAA to develop an integrated recruitment, selection, training, and job performance data collection and analysis system. That system should be in place in time to select the personnel who will be operating those future systems. An outline for research to support selection of personnel for the future NAS architecture is described in Broach (1997).

Summary

While Billings (1997) and Wickens, Mavor, and McGee (1997) have reviewed and identified a number of human factors that need to be addressed during the transition to the more automated ATC system of the future, in this paper we have sought to identify personnel-related issues and concerns. The projected future increase in air traffic, aging of the ATC workforce, and increased requirements to train both new personnel and members of the existing workforce to operate the future more automated ATC system, will need to be addressed. With the advent of the new technologies, there is also a clear need to identify the knowledge, skills and abilities required to perform the duties of the future controller and to develop instruments to support the recruitment and selection of individuals who can best operate those systems.

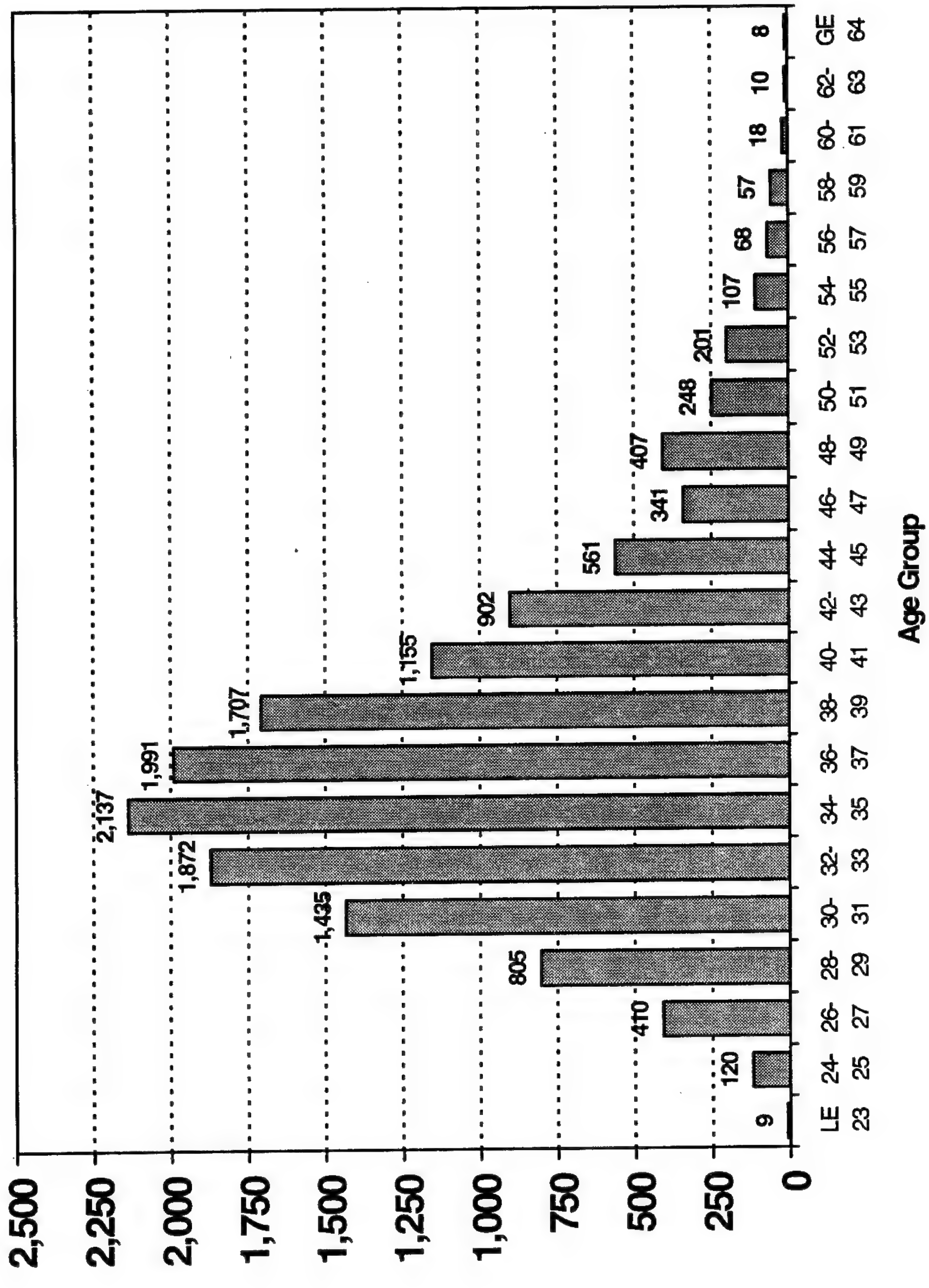


Figure 6–1: Age distribution of controller workforce (N=14,569) as of April 1996

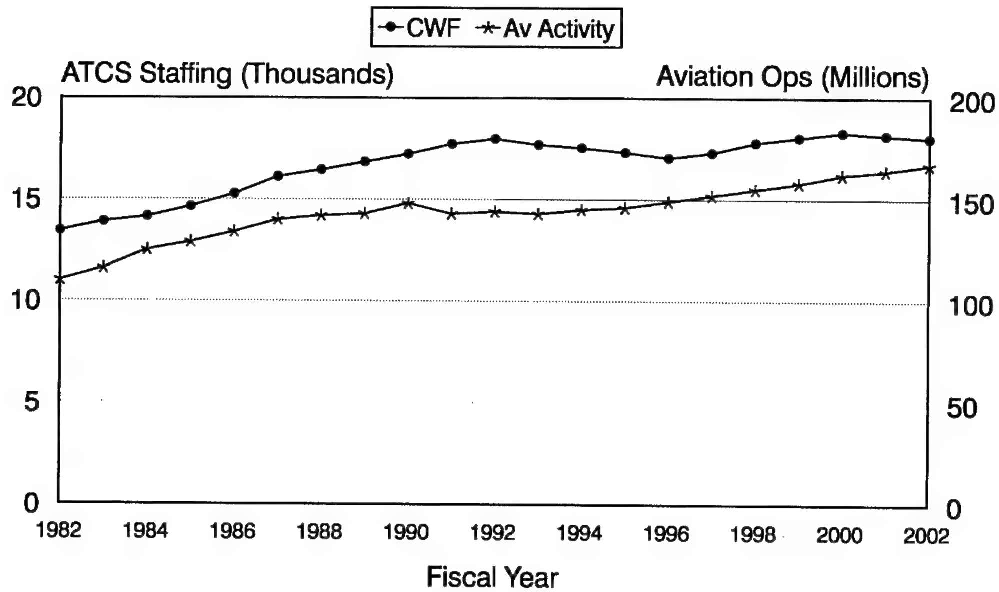


Figure 6–2: Projected controller workforce (CWF) vs. aviation activity (1982-2002).

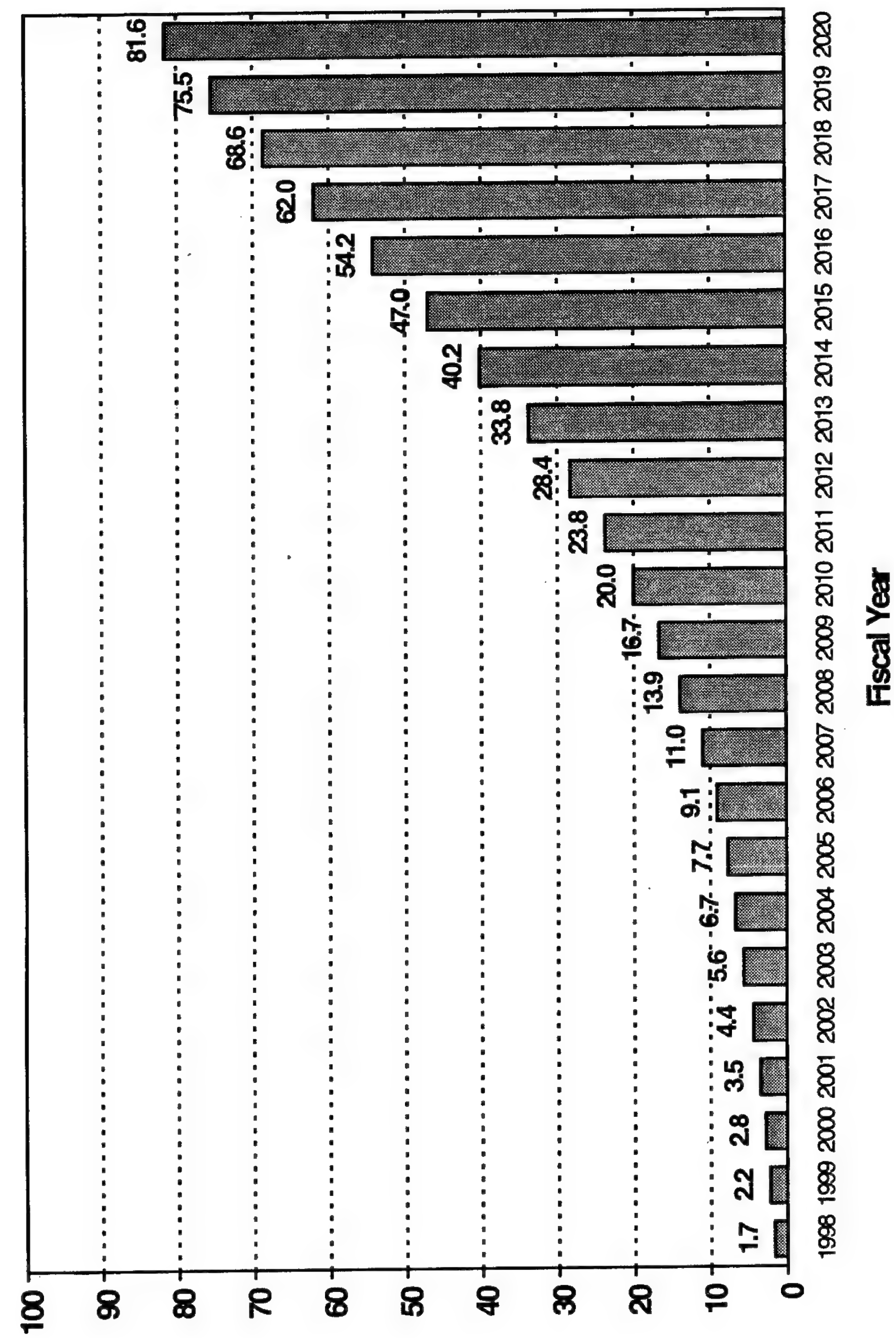
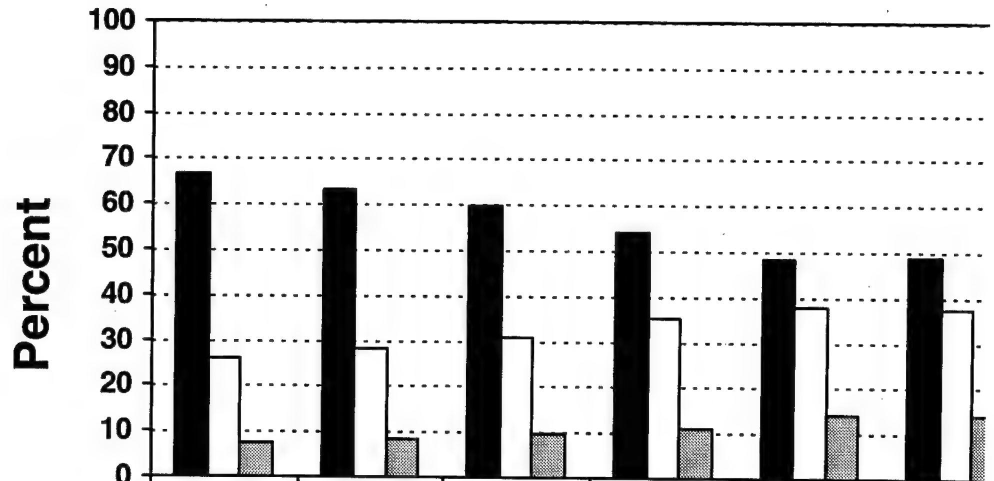
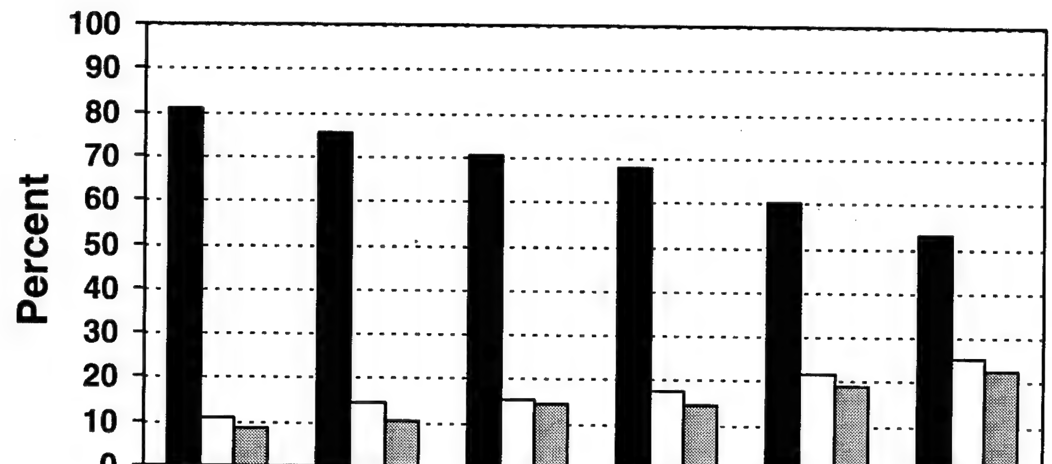


Figure 6–3: Controller retirement eligibilities after the year 2000



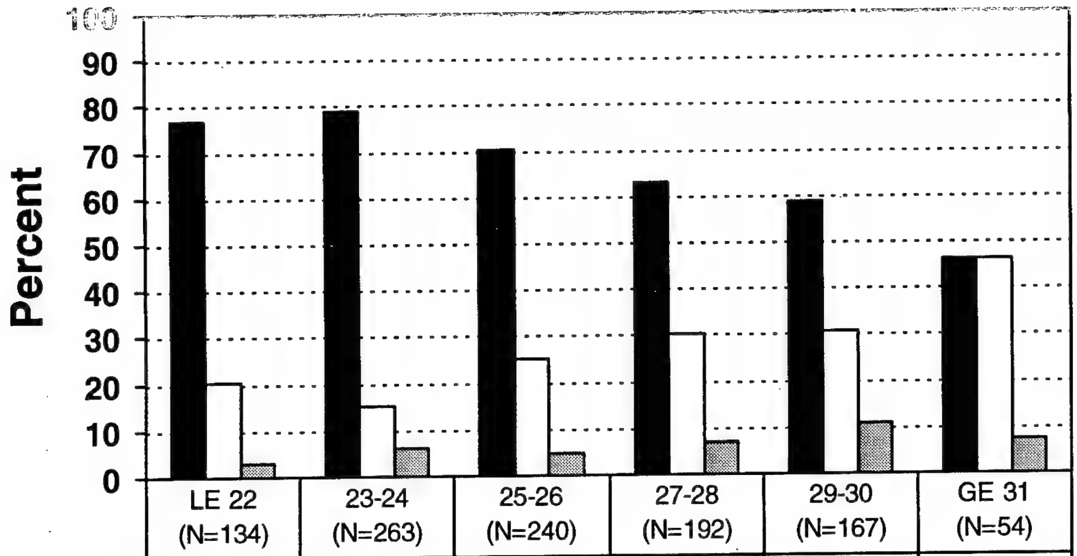
	LE 22 (N=3,320)	23-24 (N=5,987)	25-26 (N=6,036)	27-28 (N=5,692)	29-30 (N=4,762)	GE 31 (N=2,12
■ PASSED	66.63	63.35	59.77	53.74	48.19	48.64
□ FAILED	25.81	28.23	30.57	35.22	37.72	37.17
▩ WITHDREW	7.56	8.42	9.66	11.03	14.09	14.19

Figure 6–4: FAA Academy outcomes by age group for all entrants, 1981-1992



	LE 22 (N=1,305)	23-24 (N=2,190)	25-26 (N=2,015)	27-28 (N=1,624)	29-30 (N=1,150)	GE 31 (N=464)
■ FPL	80.69	75.39	70.62	67.86	59.91	52.80
□ Switched	10.73	14.38	15.09	17.61	21.39	25.00
▩ Failed	8.58	10.23	14.29	14.53	18.70	22.20

Figure 6–5: OJT outcomes at first facility by age category for FAA Academy graduates initially assigned to en route centers ($N = 8,748$)



	LE 22 (N=134)	23-24 (N=263)	25-26 (N=240)	27-28 (N=192)	29-30 (N=167)	GE 31 (N=54)
Made FPL	76.87	78.71	70.42	63.02	58.68	46.30
Switched	20.15	15.21	25.00	30.21	30.54	46.30
Failed	2.99	6.08	4.58	6.77	10.78	7.41

Figure 6–6: OJT outcomes at first facility by age category for FAA Academy graduates initially assigned to Level 4 and 5 terminals (*N*=1,050)

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